Project Report Format

Team Id	NM2023TMID04415
Project Name	Block chain Technology For Electronic Health Records

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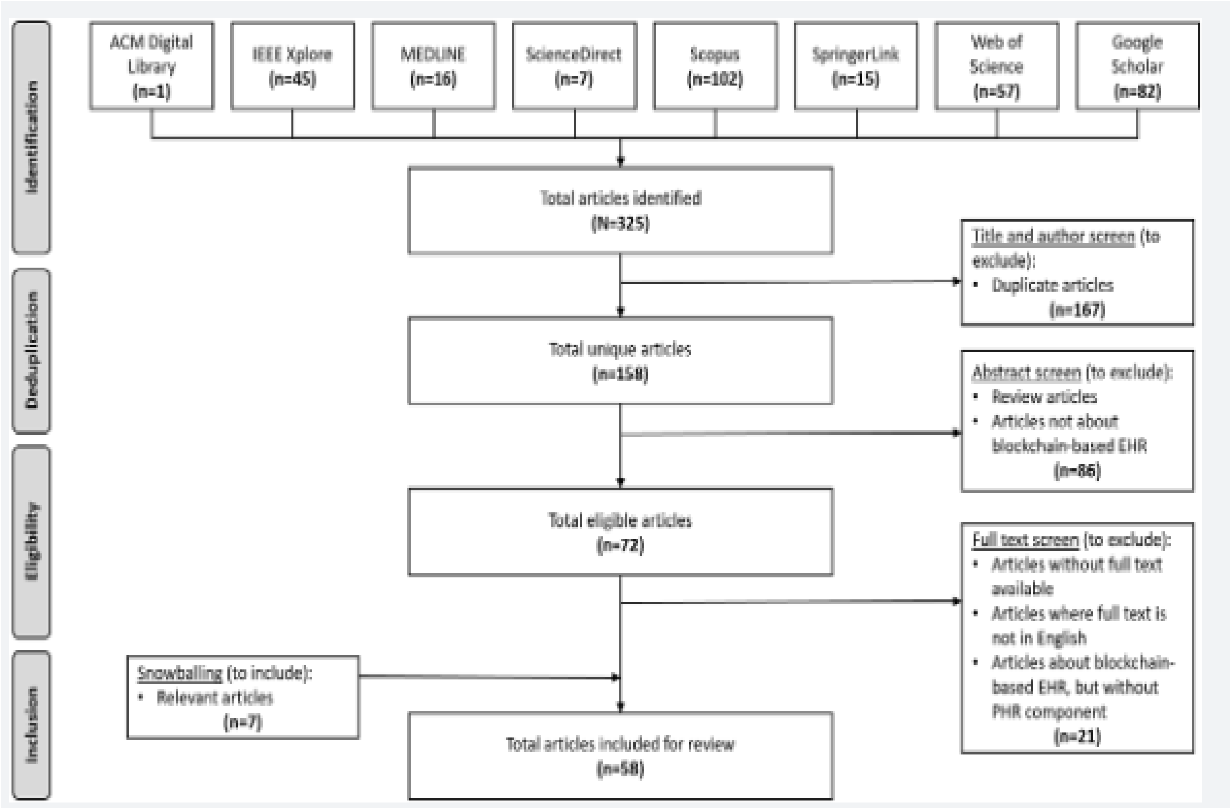
INTRODUCTION :

Block chain Technology introduced a financial application that has started a revolution in many fields including healthcare information systems. Block chain technology can provide a solution that not only helps to secure recording and sharing of medical records but also to assure the privacy of each patient's data by giving their medical data ownership to the patients, themselves. In this study, we conducted a systematic literature review on block chain technology and healthcare research. In the following section, we reviewed the concepts of block chain technology.

1.1 Project Overview:

The search performed on July 6, 2020, yielded 325 articles, of which 158 were unique articles. From the article selection process, 51 articles were selected for review. An additional 7 articles were added via snowballing (review of the references from the included articles) of the full texts screened.

Overview Flow Chat:



[a]EHR: electronic health record.

[b]EMR: electronic medical record.

[c]IoT: internet of things.

[d]BHEEM: Blockchain-based framework for efficient storage and maintenance of electronic health records

[e]PHR: personal health record.

[f]FHIR: Fast Healthcare Interoperability Resource.

[g]IPFS: Interplanetary File System.

Current Landscape and Trends of Block chain PHRs:

Interest Group:

The level of academic interest in the space has been rising, supported by an increasing trend in the number of published articles since 2016. In terms of interest groups, 45 articles were CS-or engineering-related publications or from CS- or engineering-related authors. Seven were published in medical journals, all of which were related to medical informatics. Of the 6 remaining articles that were classified as *General*, 5 were whitepapers.

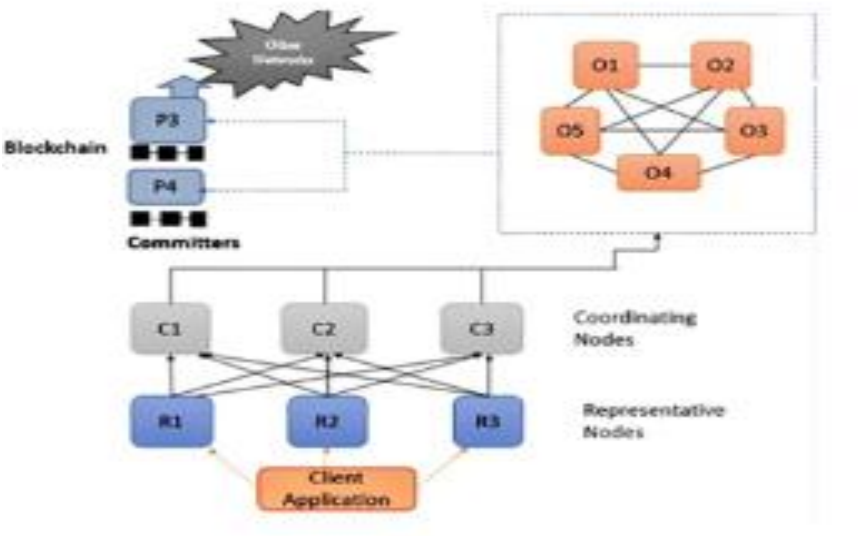
Geographic Distribution:

The articles originated from 23 different countries. The majority were from India (n=13), United States (n=9), China (n=8), and South Korea (n=5), with Canada, Switzerland, Taiwan, and Thailand having 2 articles each and the remaining countries having 1 article each (Figure 4). Although the research interest in blockchain PHR is multinational, there clearly are a few countries that are leading the pack. Among these leading countries, there has been an increasing number of publications from India over the years, whereas China, South Korea, and the United States have shown a slowing trend.

Purpose:

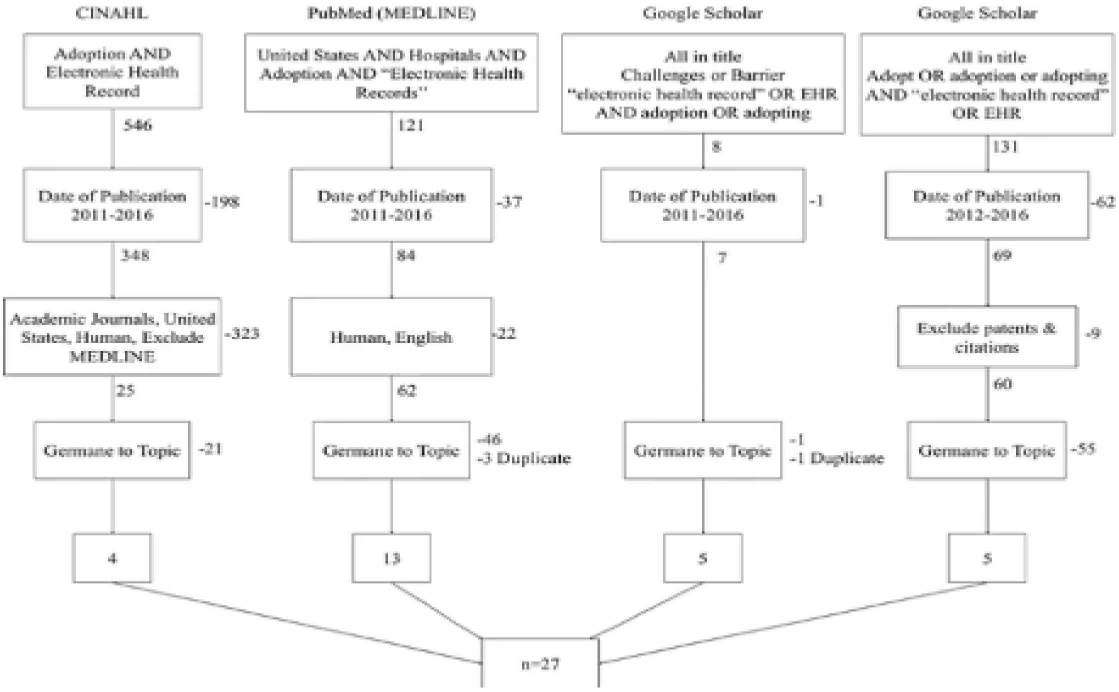
We propose a secure peer-to-peer and decentralized framework for all healthcare providers and patients to maintain and manage demanding healthcare data. The proposed framework is based on a cryptographic POS consensus mechanism. The main reason to use blockchain is because of its property of immutability. Hyperledger builds confidential smart contracts among two parties using a POS consensus algorithm to exchange healthcare data, which improves data privacy by isolating transactions and consumes less energy and computation power. The design of the proposed framework is represented in Figure 4. The framework provides secured sharing and storage of EHR among individuals and stakeholders.

Block chain architecture in healthcare domain:



LITERATURE SURVEY:

Three databases were used to acquire articles for this review: Cumulative Index of Nursing and Allied Health Literature (CINAHL), PubMed (MEDLINE Complete) and Google Scholar. We identified articles for research based upon their relevance to the topic of barriers to adoption of EHRs. To achieve the desired field of germane articles for our research, we used key words and similar terms in conjunction with Boolean operators tailored to the search engine of the database. Fig. 1 illustrates our search methodology as well as the various search strings used to call up eligible articles.

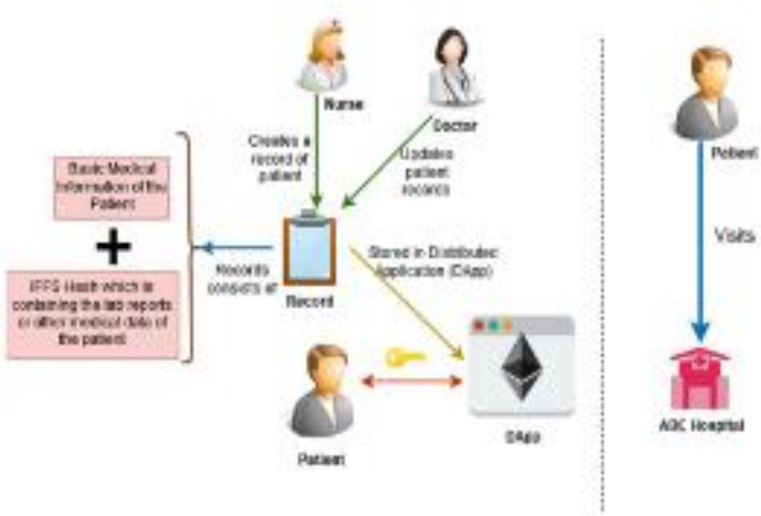


Small terminology differences existed between research databases because the databases index differently and often use different subject headings. For instance in CINAHL, the search string was "Adoption AND 'electronic health record'" while the search in PubMed needed to be a bit more complex. We included both studies and reviews if they met our eligibility criteria.

2.1 Exiting Problem:

A descriptive study of 100 nursing personnel at a large Magnet hospital in Southwest Florida was conducted to assess their needs, preferences, and perceptions associated with Electronic Health Record (EHR) documentation methods. Nurses' attitudes about the use of EHRs and their perceived effects on patient care were assessed.

The five-item, Likert-type attitude scale explained 54% of the variance in attitude scores and demonstrated sound construct validity and internal consistency (*r* = 0.77). More than one third, 36%, perceived that EHRs had resulted in a decreased workload. The majority of nurses, 64%, preferred bedside documentation but reported that environmental and system barriers often prevent EHR charting at the bedside. Overall, 75% of nurses thought EHRs had improved the quality of documentation and 76% believed electronic charting would lead to improved safety and patient care.



2.2 References:

- Popescu-Belis A, Lalanne D. Reference resolution over a restricted domain: references to documents.
- Ontology-based error detection in SNOMED-CT
- Coding systems and classifications in healthcare: the link to the record
- Ceusters W. Language, medical terminologies and structured electronic patient records: how to escape the Bermuda Triangle.
- Towards industrial-strength philosophy. How analytical ontology can help medical informatics
- Relations in biomedical ontologies
- Referent tracking in electronic healthcare records
- ontology as reality representation
- A formal theory of substances, qualities, and universals
- Reasoning with biomedical terminologies. J Biomed Inform, in press.

Problem Statement Definition:

Research and development projects are ongoing in several countries around the world to develop an infrastructure for national health information; examples include Canada [1], Australia [2], England [3], the United States [4] and Finland [5]. These projects share in common a number of elements, including (1) the aim of involving patients in the use of their own health records; (2) the need to define the core information of these records; (3) the choice and implementation of standards, nomenclatures, codes and vocabularies; (4) the need to develop the necessary data security infrastructure and policies; (5) the aim of producing open, standardized and interoperable EHR systems for data exchange and information management.

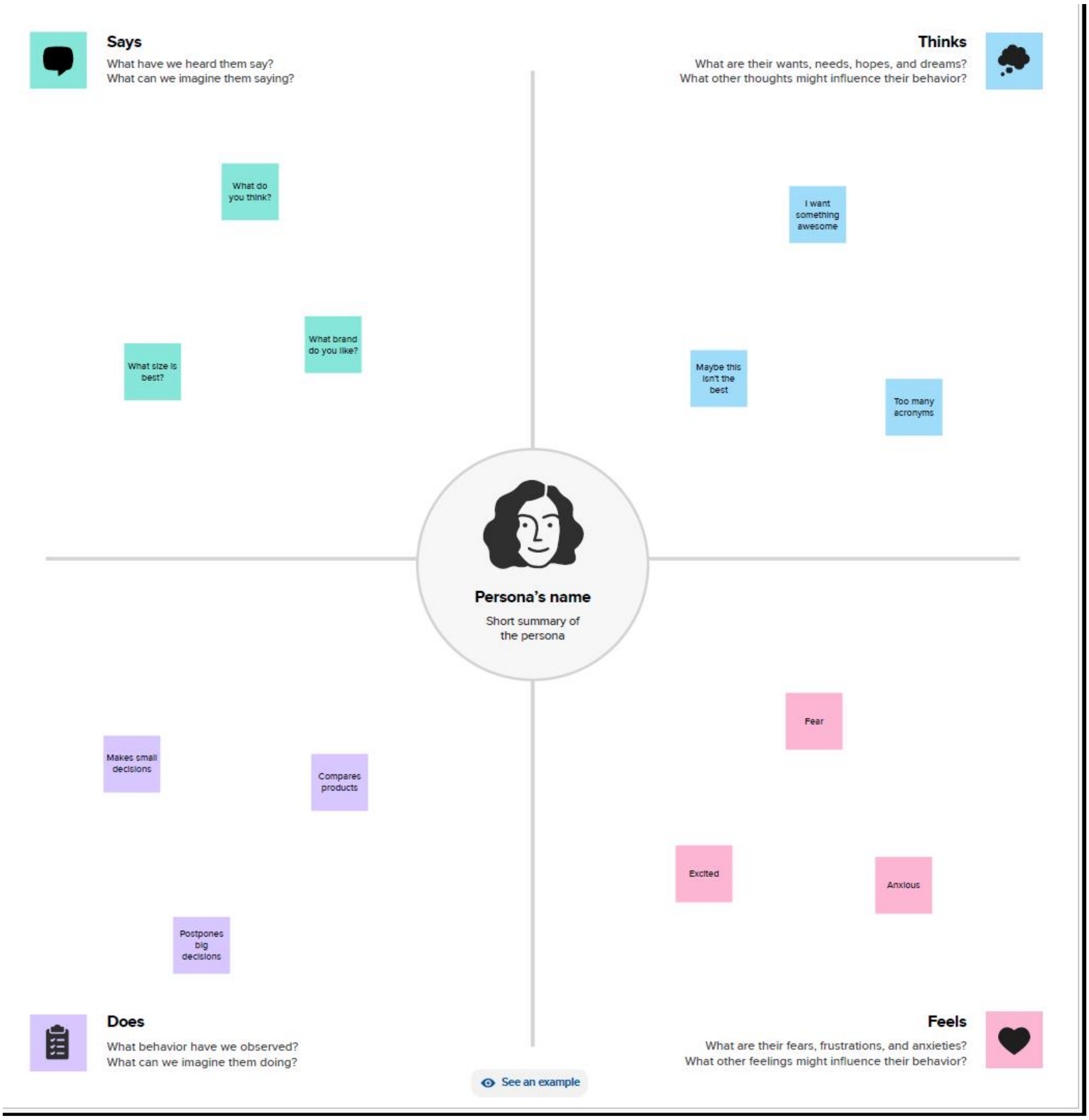
Materials and methods:

An automated literature search was conducted on four databases with the assistance of a librarian. The databases were PubMed/Medline (National Library of Medicine, Bethesda, MD, USA), Cinalh (Cinahl Information Systems, Glendale, CA, USA), Inventory of Evaluation Publications (University for Health Informatics and Technology, Tirol Research Group Assessment of Health Information Systems) and Cochrane (The Cochrane Collaboration). On the *Cumulative Index of Nursing and Allied Health Literature*

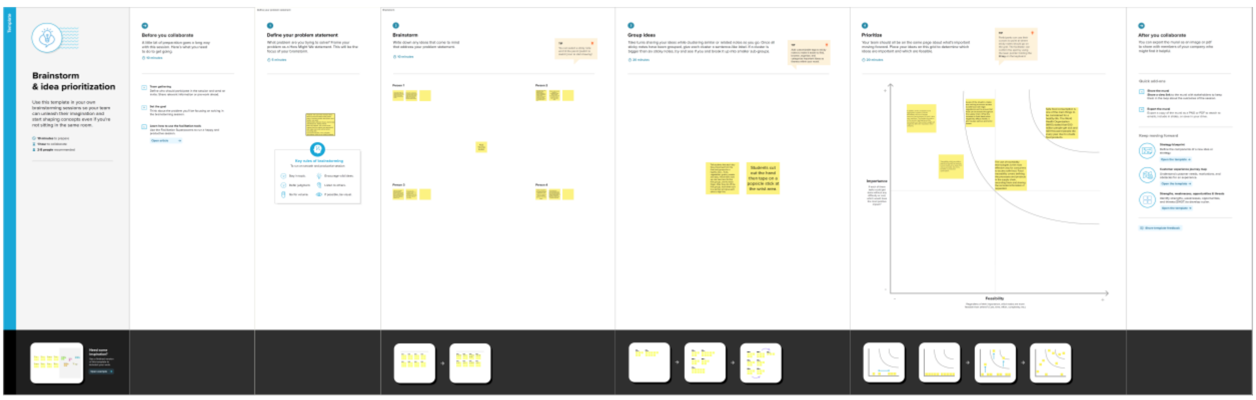
IDEATION & PROPOSED SOLUTION:

Furthermore, we incorporate attention schemes to improve performance in long sequences and time-independent pre-trained schemes to cope with very short sequences. Using a database of 1023 patients, our experimental results show that the addition of EMA records boosts the system recall to predict the suicidal ideation diagnosis from 48.13% obtained exclusively from EHR-based state-of-the-art methods to 67.78%. Additionally, our method provides interpretability through the t-distributed stochastic neighbor embedding (t-SNE) representation of the latent space. Furthermore, the most relevant input features are identified and interpreted medically.

3.1 Empathy Map Canvas:



3.2 Ideation & Brainstorming:



4. REQUIREMENTS ANALYSIS:

Today's information processing in health care facilities is usually primarily directed towards the information needs of the respective institution [1]. However, patient related medical data are needed as well outside the hospitals walls, i.e. by general practitioners, health insurance companies or pharmacies.

Methods:

First, in an initial literature analysis (using pub med and Google scholar) and in brainstorming meetings within the project team (consisting of a medical computer scientist, a medical doctor, a software developer, a network expert and a bio-statistician) a set of players in the health care system was identified.

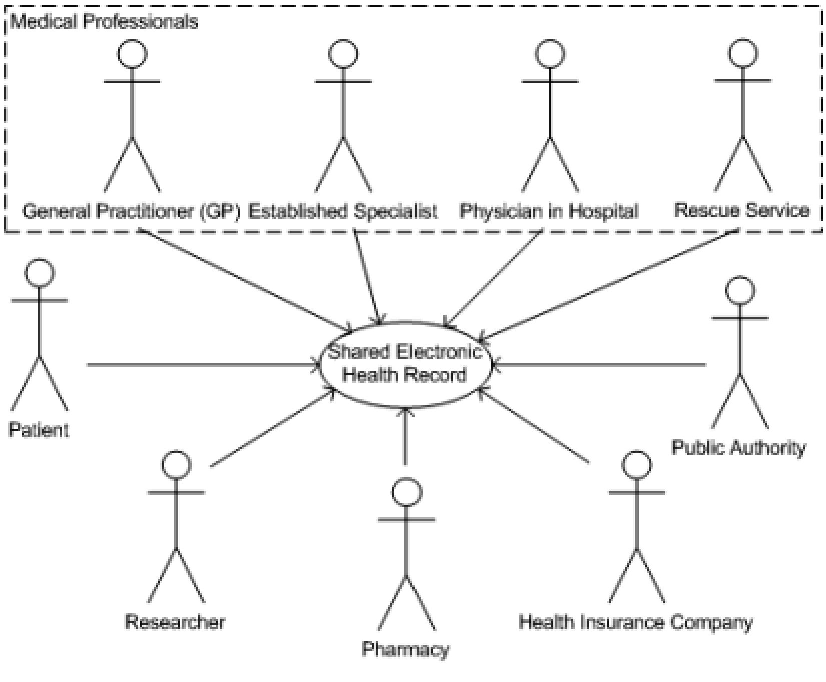
Players in an inter-networked health information system:

In the initial brainstorming phase the following players were identified (figure 1):

- Patients
- Medical professionals (general practitioners, established specialists, physicians in hospitals, rescue services)
- Pharmacies
- Researchers (epidemiologists, medical and public health scientists, statisticians)

- Health insurance companies
- Public authority (governmental institutions, controlling institutions of health care system, civil protection services)

Player in a networked health care system:



4.1 Functional requirement:

There are a lot of software requirements specifications included in the functional requirements of the Hospital Management System, which contains various processes, namely Registration, Check, Report Generation, and Database.

Registration Process of SRS (Software Requirements Specification):

- Adding Patients: The Hospital Management enables the staff at the front desk to include new patients in the system.
- Assigning an ID to the patients: The HMS enables the staff at the front desk to provide a unique ID for each patient and then add them to the record sheet of the patient. The patients can utilize the ID throughout their hospital stay.

Report Generation of SRS:

- Information of the Patient: The Hospital Management System generates a report on every patient regarding various information like the patient's name, Phone number, bed number, the doctor's name whom it assigns, ward name, and more.
- Availability of the Bed: The Hospital Management system also helps in generating reports on the availability of beds regarding information like bed numbers unoccupied or occupied, ward name, and more.

Database of SRS:

- Mandatory Patient Information: Every patient has some necessary data like phone number, first and last name, personal health number, postal code, country, address, city, 'patient's ID number, etc.

- Updating information of the Patient: The hospital management system enables users to update the information of the patient as described in the mandatory information included.

4.2Non-Functional Requirements:

There are a lot of software requirements specifications included in the non-functional requirements of the Hospital Management System, which contains various processes, namely Security, Performance, Maintainability, and Reliability.

Security:

- Patient Identification: The system needs the patient to recognize herself or himself using the phone.
- Logon ID: Any users who make use of the system need to hold a Logon ID and password.

Performance:

- Response Time: The system provides acknowledgment in just one second once the 'patient's information is checked.
- User-Interface: The user interface acknowledges within five seconds.

Maintainability:

- Back-Up: The system offers efficiency for data backup.
- Errors: The system will track every mistake as well as keep a log of it.

Reliability:

- Availability: The system is available all the time.
- Hope you got a clear idea of the functional and non-functional requirements and the features required by the hospital. Any other queries on the topic are welcome.

5. PROJECT DESIGN:

Software usability should always be key. This does not reflect well in the case of many **electronic health records (EHR)** & **electronic patient records (EPR)**. Based on our experience in the design of electronic health records, we'll share insights from benchmarking highlighting good practices and common issues.

The State of Digital Health Records in 2022:

The HIMSS 2022 State of Healthcare Report shows that there is an **increased demand for the implementation of EHR systems**, or digital health records. The integration of electronic records could improve the patients' experiences with the medical system. More than this, using such **digital records has the added benefit of reducing errors**, while also offering the possibility of sharing data. In a field where even the most minute error can have a drastic effect, digitisation slowly decreases the risk of error. Such a **shift towards digital data** contributes to the overall quality & efficiency of the healthcare sector.

Key challenges of digital records design:

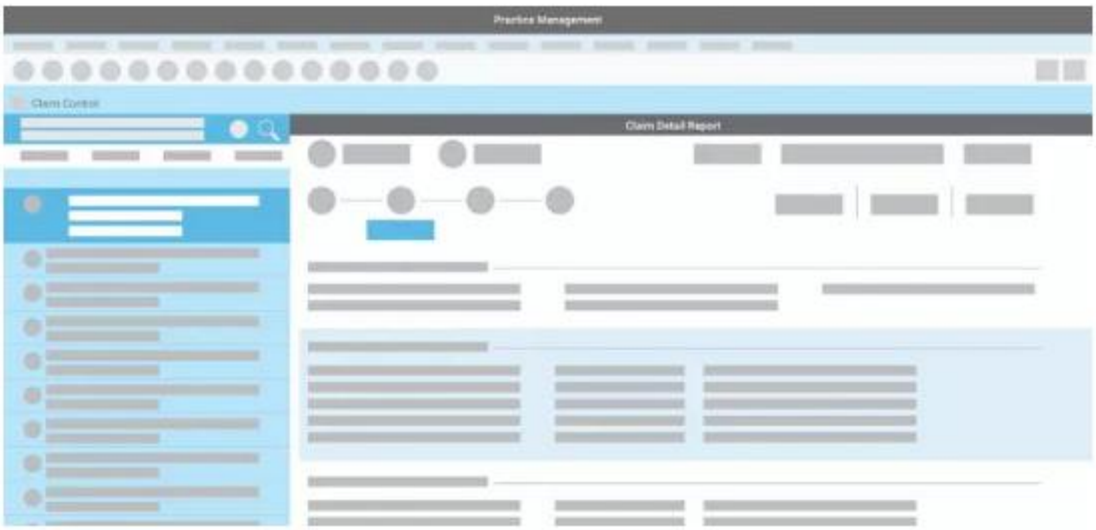
- EMRs are accessed by multiple users: physicians, caretakers, lab workers, pharmacists, etc. EMRs rarely have workflows/modules that fit each user's agenda. This means that **healthcare workers spend more time navigating the system** because they can't perform the needed actions for their work.

- **Digital medical systems** dictate how clinicians should do their work, what steps to follow and what logic to apply when interacting with patients. Most of the available GUIs aren't flexible and aren't based on the clinician's needs. This causes frustration, increases the amount of mistakes clinicians make and harms the clinician-patient interaction.

A Comparison of Digital Records Layouts:

Greenway Health Electronic Health Records:

- **This EHR has a clear top-down navigation pattern**. The controls are positioned on the upper part of the interface and offer intuitive tweaks to the displayed information.
- **Navigation menus** are placed either at the top of the screen or on the left side, in the form of a sidebar. The working area occupies the majority of the interface. **The user can easily understand the order in which the actions need to be performed.**



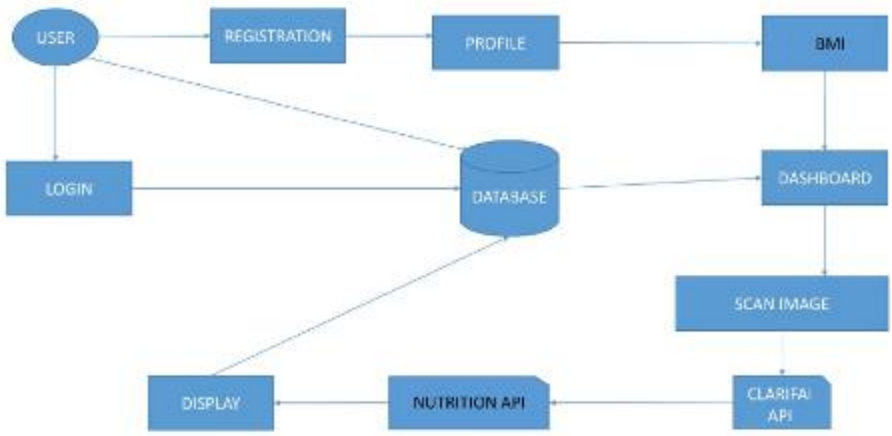
Greenway Health EHR layout

5.1 Data Flow Diagrams & User Stories:

- **[Context and otivation]** The well-established Data Flow Diagrams (DFDs) have proven their value in the field of security and privacy for the realization of processes in models. However, the time and resources required to model the system with DFD, could slow down security and privacy threat analysis. **[Question/problem]** Despite the fact that information required for drawing DFD is available in the textual requirement such as user stories, the current approach to modeling the system using DFD is still done by form/questionnaires or manually drawing the diagram.
- **[Principal ideas/results]** This study proposes a natural language processing (NLP) model that generates DFD automatically from well-formed user stories. We also detect the presence of personal data in user stories by employing Named Entity Recognition, which allows the personal data to be highlighted in DFD. Our preliminary results show that our model can automatically generate a DFD that highlights the presence of personal data. Finally, the DFD could be expanded to a Privacy-Aware DFD, which incorporates privacy checks into the DFD. **[Contribution]** This is the first attempt at automatically transforming user stories into DFD using an NLP approach. The automatic approach may alleviate the burden placed on privacy analysts during the initial stages of

threat modeling or eliciting privacy requirements.

Data Flow Diagrams:

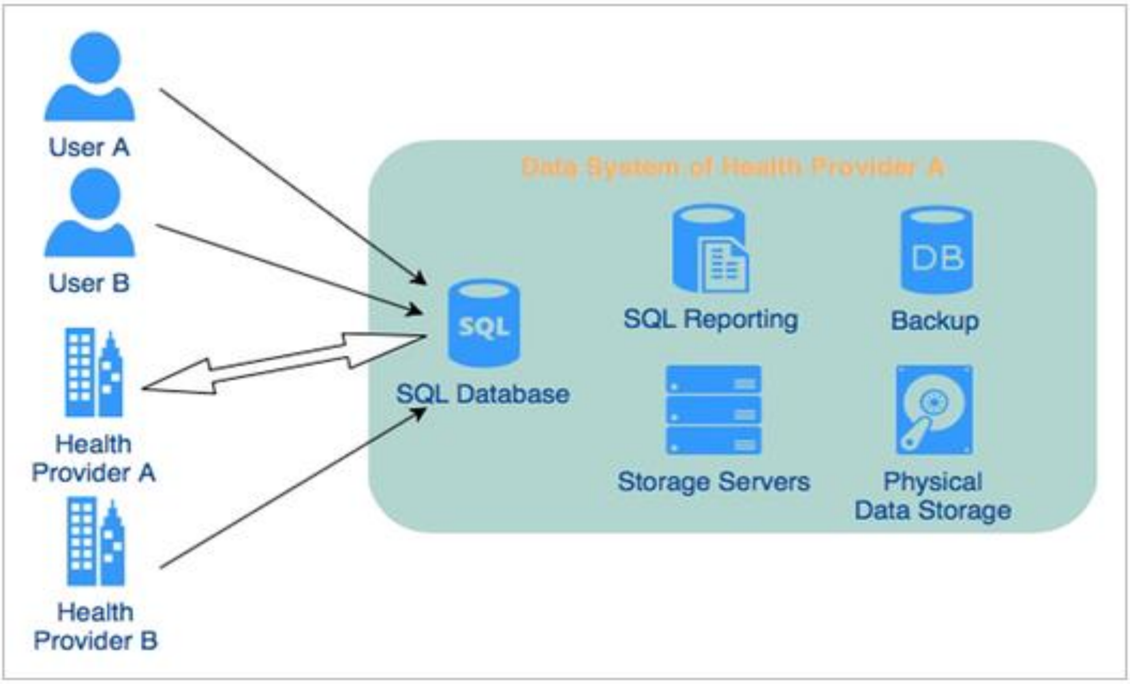


User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Web user)	Registration	USN-1	As a user, I can register for the application by entering my email, and password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
	Profile	USN-3	As a user, I can enter my Height, weight, age, gender and Activity level.	I can update my profile	High	Sprint-1
	Login	USN-4	As a user, I can log into the application by entering email & password	I can access my dashboard	High	Sprint-1
	Dashboard	USN-5	As a user, I can track my progress	I can access my dashboard	High	Sprint-2
		USN-6	As a user, I can upload food image	I can get nutritional values of that food	High	Sprint 2
Customer Care Executive	Customer care	USN-7	Providing support for users	Users can get 24/7 support	medium	Sprint 3
Administrator	Maintain application	USN-8	Maintaining details for uses	I can access database	High	Sprint 4

5.2 Solution Architecture:

- National health professionals operate various healthcare services at different locations. Usually, a user visits more than one health professional, eg, general practitioner, specialists, clinics, pharmacies, etc, for different needs. Figure 1 shows a scenario in the current healthcare systems, where records issued by a health provider are stored locally in the provider's data system. The provider handles all the management and maintenance of the data, most of which are database related tasks.
- Example tasks include SQL reporting, the database backup, system recovery, etc. It is not uncommon to utilize the storage server solutions, and some of the providers have to take the physical data storage into their consideration also. Only this provider has the edit right to the records. Provided with access rights to the databases, users can query their records from different providers. Providers can also query records of a common user from other providers when they need, eg, consulting related records for making a diagnosis.



Electronic health record (EHR):

Elektronisk pasientjournal (EPJ) is the Norwegian Electronic Patient Record format that records health information of users and has been primarily used by health providers in Norway. An EPJ system stores EPJ files in databases and offers an interface for registering, searching, and displaying information from the EPJ files, etc. Such databases are (partly) open to users and other providers with different specified permissions. Currently, this EPJ system, like the electronic health record (EHR) systems in many other countries, is fragmented across health providers and the entire system has yet to be integrated. The health records of a user are maintained in different health providers' databases; thus, providers cannot have a comprehensive overview of all the records of a single user.

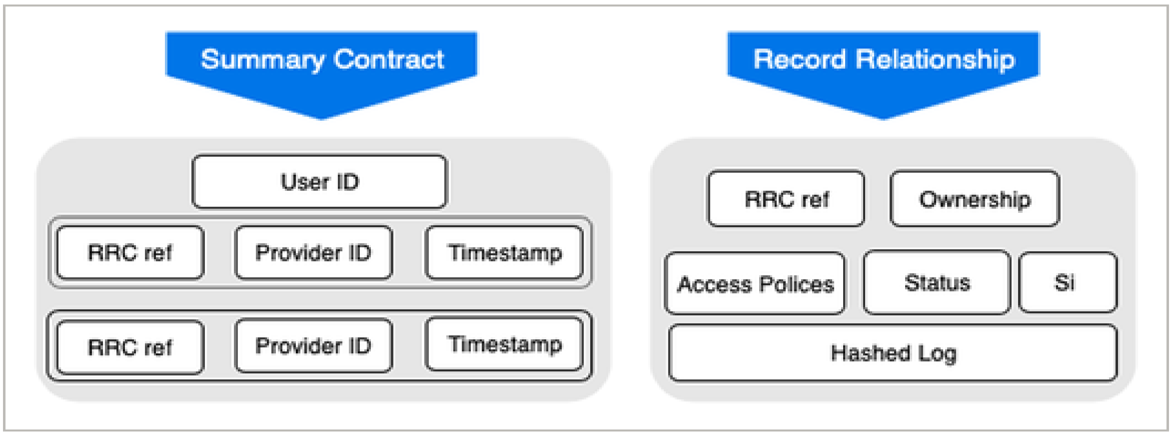
A BLOCKCHAIN-BASED ARCHITECTURE:

Overview:

1. To alleviate health providers' workload of adopting the blockchain solution, we propose an architecture building on top of the existing providers' databases. All accesses to the health records in these SQL server databases have to go through the blockchain, which then keeps track of all logs of queries, such as select, insert, delete, etc. Ownerships and access rights of records are important metadata added to the chain in addition to the logs. In this way, the history of all accesses is stored on the blockchain that provides a full view of all events that have happened to each record and hence guarantees data integrity and prevents misuse of user records.
2. Since users do not store records but only read, and each provider is responsible for data management and maintenance; we only let providers be involved in the maintenance of the blockchain. In this design, we also propose a new incentive mechanism, where a concept of *significance* of each provider is introduced and used as the main factor for selecting a provider who is responsible for creating a new block. Associated with this architecture, we design the smart contracts as Figure 2 shows.

- **Summary contract** (SC) holds a list of references of providers that a user has records with. A user-provider relationship is identified by a user ID and a provider ID. Associated with each user-provider pair is a reference number to the corresponding Record Relationship Contract (RRC) and a timestamp for the last edit of the record.

- **Record relationship contract** (RRC) stores metadata of a record. Such metadata includes ownership, access policies that indicate which entities are authorized to access the record, a status indicates if the updated RRC has been added to the blockchain or not, the current significance of the provider, and hashed logs of all read and write events that have happened to the record since the last update.



6. PROJECT PLANNING & SCHEDULING:

PROJECT PLANNINHG:

EHR Implementation Plan:

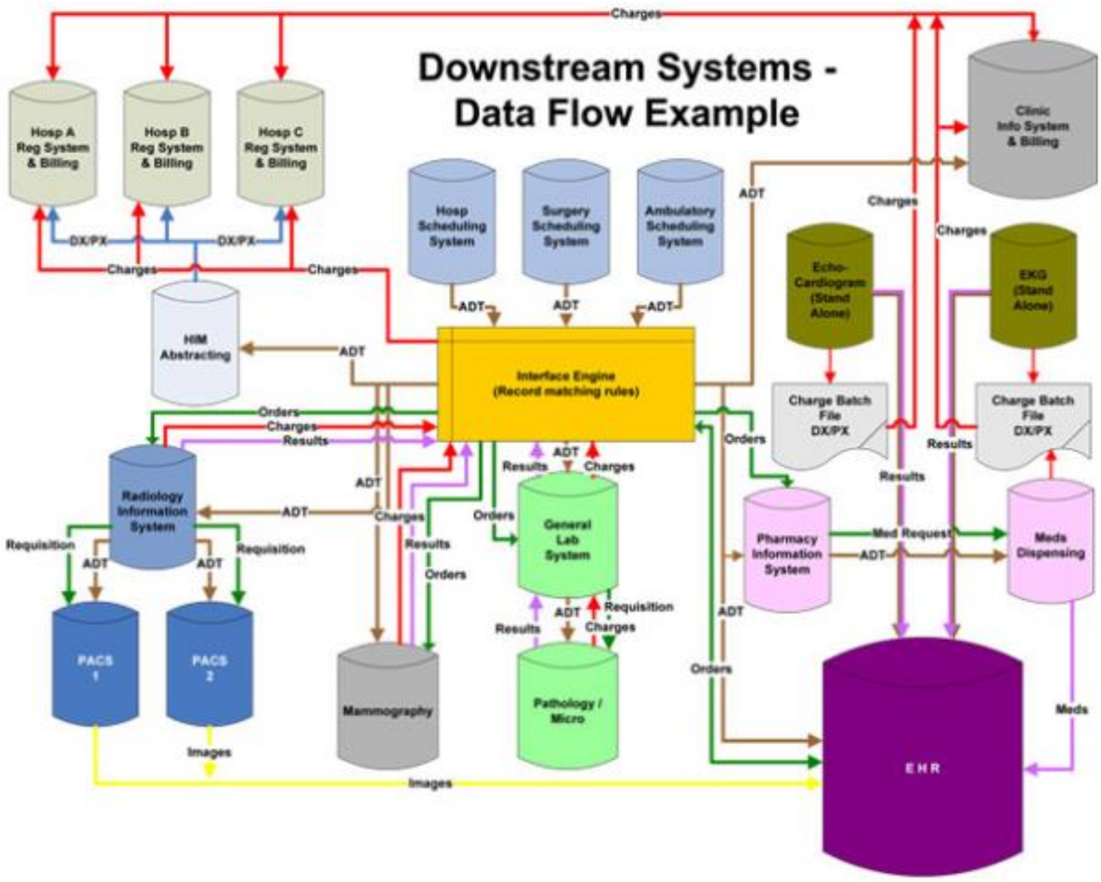
An EHR implementation is the process of planning and carrying out the integration of EHR software and components in a healthcare organization. Implementation is a term that is not specific to EHR systems, it refers to integrating a software-based service or component into the workflow of an organizational structure or an individual end-user. An EHR system implementation is an organization-wide effort - the impacts of which will be felt by everyone from physicians and administrative staff all the way to the patients.

Migration of patient data and practice data:

This is the point where the everyone has to keep their nose to the grindstone. Or their cleansed patient data to the well-formatted EHR database if you want to be literal.

Key stages in EHR data migration include:

- Conversion of paper records to electronic records
- Data cleansing and verification
- EHR database setup
- Mapping legacy data to new database fields
- Data transfer to the new system
- Testing and verification of legacy data
- Testing and verification of new data inputs



PROJECT SCHEDULING:

Appointment scheduling is incredibly important for your medical or dental practice, as it ensures you keep your schedule full, maximizing your ROI.

To simplify practice management for your team, you’ll want to rely on an appointment scheduling solution with EHR integration and deliver a patient experience that converts more appointments. With patient details readily available at the time of booking, it’s easier to manage patient appointments and efficiently fill appointment slots.

EHR scheduler:

An EHR scheduling software, or EHR scheduler, is a solution that enables dental and medical patient scheduling, integrating directly with an EHR system for easy access to patient information. Manage appointments electronically with online patient scheduling, automating much of the process with an EHR integration.

Use EHR for Timely Workflow:

Spending time to develop an accurate, data-driven patient scheduling process is wasted if everyone in the office doesn't work to keep the workflow on time. Certainly, physicians can't rush patients through every process or bail when individuals have questions or needs. Office staff can use EHR systems to ensure necessary information is always on hand and assist clinical staff in treating multiple patients at one time. You can also use records to identify complex cases, which should be scheduled with longer expected treatment times and never back to back.

Electronic Healthcare:

Healthcare analytics will become a normal part of your daily routine. It will enable you to gain even more insight into complex scenarios and diagnostic challenges. As part of the evaluation process, this is the right time to determine whether your new EHR system is ready for new technologies like machine learning & artificial intelligence.

6.1 Technical Architecture:

Clinical care increasingly requires healthcare professionals to access patient record information that may be distributed across multiple sites, held in a variety of paper and electronic formats, and represented as mixtures of narrative, structured, coded and multimedia entries. A longitudinal person-centred electronic health record (EHR) is a muchanticipated solution to this problem, but the challenge of providing clinicians of any profession or speciality with an integrated and relevant view of the complete health and health care history of each patient under their care has so far proved difficult to meet

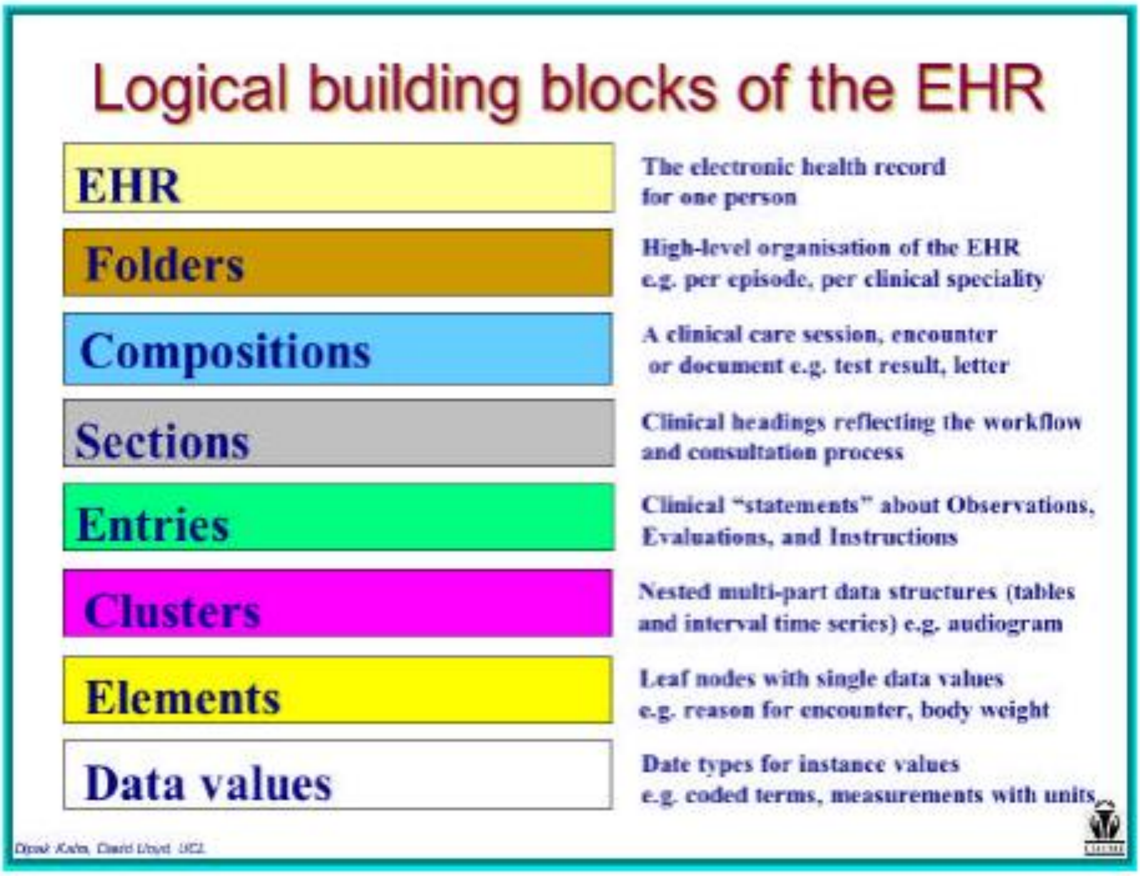
The EHR Architectural Approach:

The architectural approach to representing the EHR has its origins in research undertaken through the EU Third, Fourth And Fifth Health Telematics Framework Programmes. The increasing limitations of paper-based records, the potential benefits of electronic health records and the akknowledged challenges of delivering these in practice have stimulated a considerable investment in research and development over the past decade.

Other Relevant Contemporary Work in CEN:

- CEN standard ENV 13940 defines a set of concepts for health care parties, threads of
- aspects of a patient’s care in hospital, and are the most widely used

internationally within a hospital
information system.



6.2 Sprint Planning & Estimation:

Intervention:

The Sprints intervention had 3 primary components: (1) training clinicians to use existing EHR features more efficiently, (2) redesigning the multidisciplinary workflow within the clinic, and (3) building new specialty-specific EHR tools. Sprint was a quality improvement intervention, and we prioritized continuous process improvement over consistent data collection. Thus, we adjusted some survey questions over time to provide better insight, and thus the total number of respondents to some questions will differ from others. For each of the 6 clinics, the most updated survey at the beginning of that Sprint was sent to *all* clinicians in that clinic both before and after Sprint.

Sprint Timeline:

Sprints were carried out between January 16, 2016, and July 21, 2017. The Sprint leaders met with clinic leaders 90, 60, and 30 days before each Sprint to prepare for the intervention, identify EHR frustrations, and prioritize potential solutions. For pre-Sprint meetings and Sprint on-site details, see the Supplemental Material (available online at http://www.mayoclinicproceedings.org). During the course of each Sprint, all clinicians had their time protected so that they could participate in a 2-hour kickoff meeting, three 1-to-1 training sessions, and a 2-hour wrap-up session.

The Sprint Team:

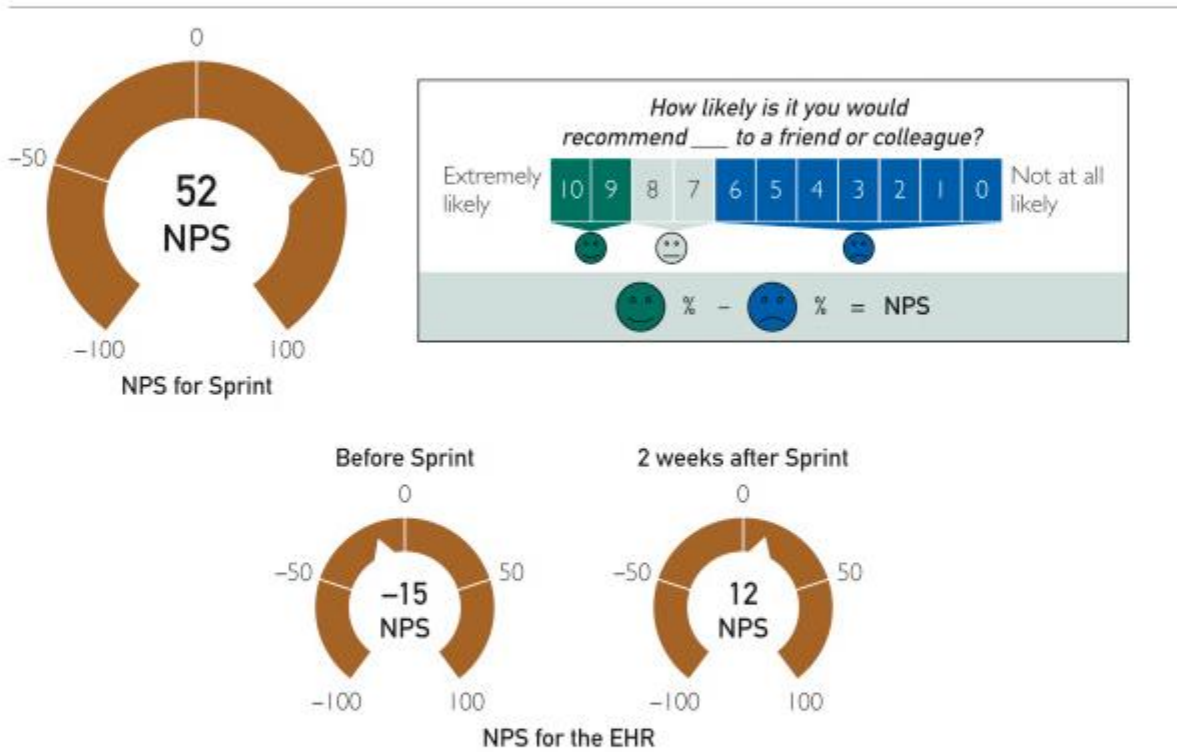
The Sprint team consisted of 1 full-time equivalent primary physician informaticist (a role shared by 2 physicians), a nurse informaticist, a project manager, 4 EHR trainers (nonclinician staff certified to teach EHR tools), and 4 EHR analysts. The physician informaticist helped translate clinician requests for EHR improvements into specific technical changes. Having the physician informaticist translate requests reduced misunderstandings and eliminated many hours of wasted EHR analyst effort. For example, a clinician's request for a complex cardiac monitoring order took up dozens of hours of EHR analyst time.

The Clinical Operations Team:

Before Sprint, organizational operational leaders (the vice president of ambulatory services and the ambulatory clinic directors) worked with the Sprint leaders to select clinics for Sprint according to each clinic's desire for EHR improvement and the presence of effective clinic leadership. In larger academic specialty clinics, each subspecialty designated one "clinical content lead" clinician to build consensus within their group, prioritize requests, communicate with the Sprint team, and review newly built EHR tools.

Satisfaction With Sprint:

We were able to survey clinicians in 5 of 6 clinics after Sprint. Because of an oversight, we did not include the NPS for Sprint question for 1 large clinic. Eighty-nine of 145 clinicians (61%) responded to the post-Sprint survey. For all respondents, the NPS for Sprint was +52 (Figure 1).



6.3 Sprint Delivery Schedule:

Evaluation of Sprint Training Activities:

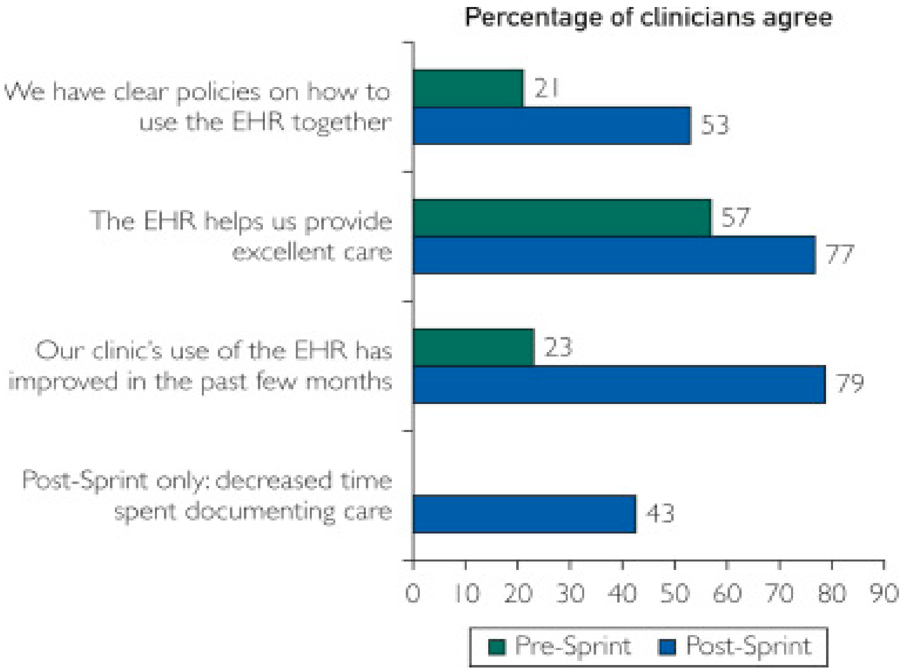
We surveyed all 186 clinicians from 2 academic clinics about the helpfulness of Sprint training activities, and 84 (45%) responded. The highest-rated activities were 1-to-1 training sessions, speech recognition training, new tools training, note-writing smart phrases, and observation/shadow sessions (Table 2)

Satisfaction With the HER:

Before Sprint, the NPS for the EHR was −15, indicating low levels of satisfaction, with 54% of clinicians (125 of 233) responding. Two weeks after Sprint, the NPS for the EHR increased to +12, with 52% clinicians (122 of 233) responding (Figure 1).

Evaluation of EHR Clinical Processes:

Two hundred five clinicians were asked about the EHR clinical process. Clinicians from the first 2 Sprint clinics did not receive these questions because they were redesigned with feedback after their Sprints. The pre- and post-Sprint response rates to the survey questions about EHR-related clinical processes were 52% (107 of 205) and 47% (97 of 205), respectively. In response to the statement "Our clinic has clear policies on how staff and clinicians can best use the EHR together," the percentage of affirmative responses (defined as either "agree" or "strongly agree") increased from 21% at baseline to 53% after Sprint (an increase of 32 percentage points).



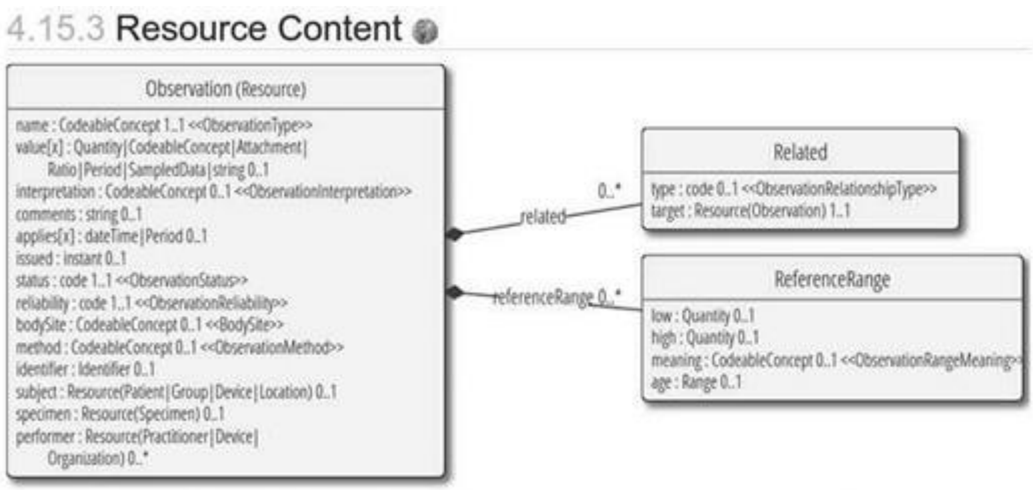
7. CODING & SOLUTIONING (Explain the features added in the project along with code):

ONC funded SMART to develop an open platform for substitutable third-party apps. The project was informed by, but operated independently of, other initiatives in ONC's interoperability portfolio (e.g., Blue Button, [4] Direct Project, [5] Nationwide Health Information Network [6]). What distinguished SMART from contemporaneous data exchange and interoperability efforts was a focus on creating immediately tangible, interoperability-supporting, vendor-independent apps (Box 1).

EHR Vendor Response:

From 2011, when we first released SMART Classic, through mid-2013, EHR vendors were not receptive. At the time, third-party medical apps were not yet an important near-term business driver. In addition, vendors raised objections to the SMART data model and API because they had not been developed in conjunction with the health IT standards community.

7.1 Feature 1:

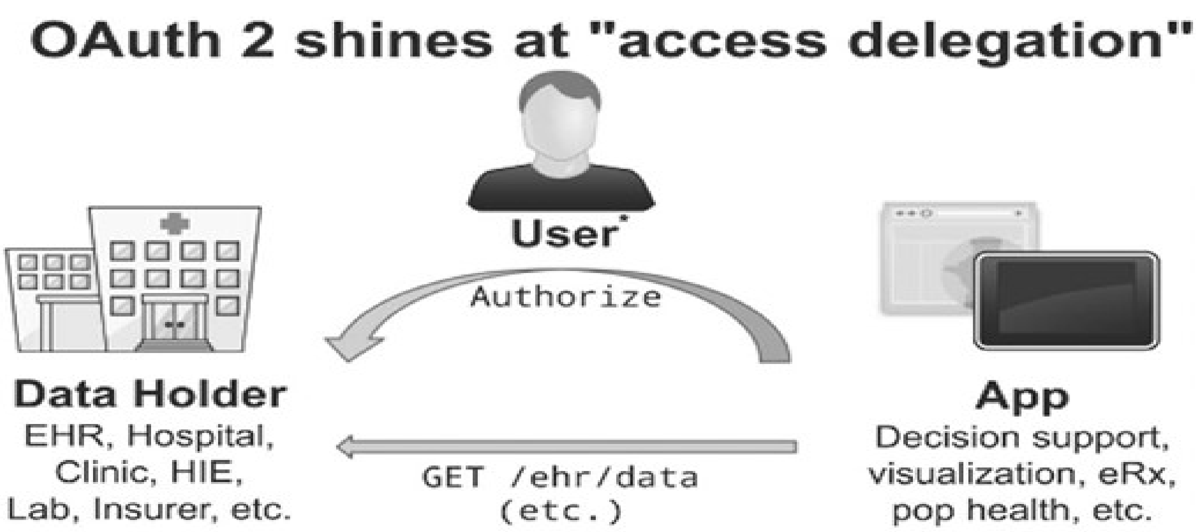


Source: Resource Content diagram from FHIR specification (http://hl7.org/fhir/observation.html)

```json
{
  "resourceType": "Observation",
  "name": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "8480-6",
        "display": "Systolic blood pressure"
      }
    ]
  },
  "valueQuantity": {
    "value": 109,
    "units": "mm Hg",
    "system": "http://unitsofmeasure.org",
    "code": "mm[Hg]"
  },
  "appliesDateTime": "1999-07-02",
  "status": "final",
  "subject": {
    "reference": "Patient/example"
  }
}
```


AFHIR Observation Resource Definition for systolic blood pressure with example in JSON.

7.2 Feature 2:



7.3 Database Schema (if Applicable):

Cross-organizational Electronic Health Record (EHR) communication, which enables authorized healthcare providers to access all relevant patient data regardless of where the data were created, will constitute a key component of future health care. The European Union acts as a political driving force behind this vision, and underlines its corresponding commitment by naming the "interoperability of EHRs" in its *eHealth action plan* as one of the goals to be strived for by member states [1].

Methods:

Our goal is to generate archetyped EHR extracts from source documents. The term *document* here refers to a form filled in with data. In Fig. 2 for example, a document for the form *Demographics* is shown, consisting of the data *20* and *m* for the variables *Age* and *Gender*. The main tasks to achieve our goal are (a) to transform the documents from their internal data model within the EHR system to the data model prescribed by the archetype, and (b) to transform the terminology used within source

Results:

As the first step, we manually derived three ISO/EN 13606 archetypes[8] from three existing openEHR archetypes “openEHR-EHR-OBSERVATION.dimensions.v1”, “openEHR-EHR-OBSERVATION.body_weight.v1”, and “openEHR-EHR-OBSERVATION.heart_rate.v1”. The conversion of an openEHR archetype to an ISO/EN 13606 archetype consists of mapping the more specific classes of the openEHR RM referred to in the former,

8. PERFORMANCE TESTING:

Practice selection:

A subset of 82 practices enrolled in a pilot rewards and recognition programme were invited to participate in the data validation study, as they had all implemented the eClinicalWorks EHR software before January 2009 and received technical assistance through the PCIP programme, and had a majority of their patient panel recorded in the EHR. Practices were required to have a minimum of 200 electronic patient records with a diagnosis of diabetes, hypertension, dyslipidemia, or ischemic cardiovascular disease.

Electronic chart reviews:

Medical reviewers randomly sampled 120 electronic patient charts per practice for established patients between 18 and 75 years of age, with at least one office visit since the practice implemented the EHR. For this study, data from the manual review of the electronic chart (e-chart) were analyzed if the patient had an office visit during the 6-month period after the activation date of the quality measurement reporting tool and implementation of the CDSS.

Analytical methods:

For each patient, each data element was coded based on whether it was documented in a structured field recognized by the existing EHR software for automated quality measurement (1=location recognized and 0=not recognized for quality measurement reporting). In addition, two sets of numerator and denominator counts were generated for each of the 11 quality measures. The first set of counts included only those patients whose information was documented in structured fields recognized by the existing software (EHR automated). The second set of counts incorporated all information about patients documented in the EHR (e-chart review). Data element coding and all counts were calculated using Microsoft Access structured query language.

8.1 Performance Metrics:

Gold Standard Medical Record Review:

Four trained non-physician reviewers analyzed charts randomly drawn from the general Medicare population described above using predefined inclusion criteria. The reviewers sequentially read charts drawn from the randomized pool until 125 diabetic patients were identified. If one of the non-physician reviewers had a question when determining the diagnosis or abstracting the measures, a physician reviewer was consulted to make the final determination.

Discussion:

As the country intensifies its efforts to standardize performance measures, and payers offer incentives to providers to adopt EHR systems, it is timely and important to assess the validity of claims data to identify populations of interest and consequently to serve as the basis for measures used in quality improvement and public reporting. In the past, claims data were often used because no other data sources were readily available for large-scale analysis. Consequently, many of the existing methods for identifying a target patient population were created to accommodate limitations of claims data. However, in the absence of true clinical data, it can be very hard to identify which patients have a condition of interest from claims data alone.

Conclusions:

While the small sample size limited the statistical power of our study, it does point out the urgent need to better understand the implications of using the two-encounter claims-based diagnosis rule before deciding on national standardized measures upon which to base public-reporting and reimbursement policies. Quality measurement organizations, the NQF, the Agency for Healthcare Research and Quality, and any coordinating body, such as the IOM's proposed National Quality Coordination Board,[19] should study this matter further to ensure that quality measures take advantage of physician-entered coded data in EHR systems.

9. RESULTS:

Purpose:

To explore the impacts that structuring of electronic health records (EHRs) has had from the perspective of secondary use of patient data as reflected in currently published literature. This paper presents the results of a systematic literature review aimed at answering the following questions; (1) what are the common methods of structuring patient data to serve secondary use purposes; (2) what are the common methods of evaluating patient data structuring in the secondary use context, and (3) what impacts or outcomes of EHR structuring have been reported from the secondary use perspective.

Methods:

The reported study forms part of a wider systematic literature review on the impacts of EHR structuring methods and evaluations of their impact. The review was based on a 12-step systematic review protocol adapted from the Cochrane methodology.

Results:

The implementation of structured EHRs can be roughly divided into applications for documenting patient data at the point of care and application for retrieval of patient data (post hoc structuring). Two thirds of the secondary use articles concern EHR structuring methods which were still under development or in the testing phase.

Conclusions:

was that of researchers and developers building improved EHRs and integrated NLP- and DSS-tools. Although structured documentation contributed to more complete and reliable records, there was limited evidence that structured EHRs would result in higher quality The most prominent secondary users' viewpoint in the reviewed articles care of patients. Further studies will need to provide valuable evidence on how structured patient data in EHRs is utilized for secondary purposes, and how

9.1 Output Screenshots:

- As information technology permeates healthcare (particularly provider-facing systems), maximizing system effectiveness requires the ability to document and analyze tricky or troublesome usage scenarios. However, real-world health IT systems are typically replete with privacy-sensitive data regarding patients, diagnoses, clinicians, and EMR user interface details; instrumentation for screen capture (capturing and recording the scenario depicted on the screen) needs to respect these privacy constraints. Furthermore, real-world health IT systems are typically composed of modules from many sources, mission-critical and often closed-source; any instrumentation for screen capture can rely neither on access to structured output nor access to software internals.
- In this paper, we present a tool to help solve this problem: a system that combines *keyboard video mouse (KVM)* capture with automatic text redaction (and interactively selectable unredaction) to produce precise technical content that can enrich stakeholder communications and improve end-user influence on system evolution. KVM-based capture makes our

system both application-independent and OS-independent because it eliminates software-interface dependencies on capture targets. Using a corpus of EMR screenshots, we present empirical measurements of redaction effectiveness and processing latency to demonstrate system performances. We discuss how these techniques can translate into instrumentation systems that improve real-world health IT deployments.

10. ADVANTAGES & DISADVANTAGES:

- There are many functions associated with patient health records. Not only is the record used to document patient care, but the record is also used for financial and legal information, and research and quality improvement purposes. Because all this information must be shared among many professionals who constitute the 'healthcare team'" (Young 92), and there continue to be problems with the paper health record, it is becoming more apparent that developing an automated health record is very important.
- An EHR also represents a huge potential for cost savings and decreasing workplace inefficiencies. "No longer are paper-based record systems fulfilling the needs of clinicians, and related healthcare workers" (Koeller 1). However, just as there are advantages and disadvantages with the paper medical record, there are also advantages

and disadvantages associated with the EHR. In addition, since an EHR is a fairly new

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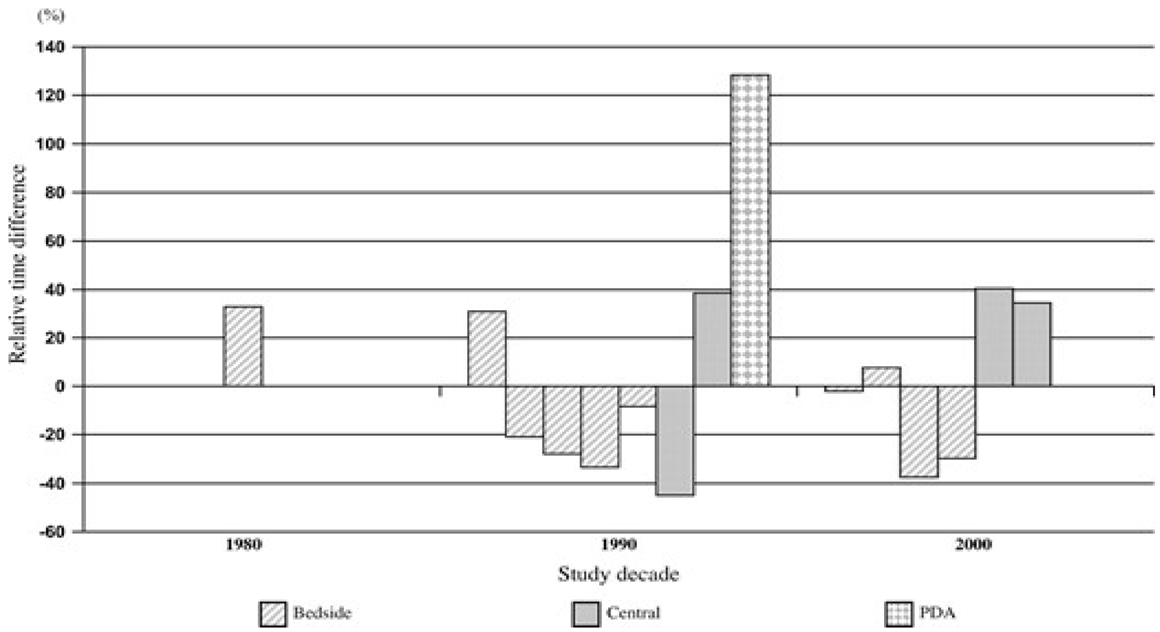
- As a management tool, the EHR can provide information to improve risk management and assessment outcomes. Today, reimbursement is based on outcomes therefore healthcare organizations “must seek innovative ways to improve quality of care and outcomes while managing costs” (Dray 3). An EHR can decrease charting time and charting errors, therefore increasing the productivity of healthcare workers and decreasing medical errors due to illegible notes.

11. CONCLUSION:

Study Characteristics:

Of the 23 studies, only two[40,41] used self-reported time and both reported an increase in documentation time with computer-based documentation. Among all reviewed papers, one third conducted their evaluation process within three months of the implementation of the computerized system.



Open in new tab Download slide

Conclusion:

- Time efficiency is one of many benefits targeted by EHR implementers, but, conversely, time inefficiency is also recognized as a major barrier to successful EHR implementation. Our initial search of the literature in the area of workflow and time efficiency allowed us to identify that the benefits of the EHR are still widely assessed from a user's perspective, looking at single processes (e.g., documentation) rather than on its impact on the set of processes involved in care delivery. We learned that expectations of EHR implementation projects that documentation time will be decreased are unlikely to be fulfilled, especially with physicians.

- This suggests that a shift from the user's efficiency to the organization's or even the system's efficiency is needed.66 Such a shift will require that the EHR be seen as a tool that can transform work processes and support innovation in care delivery.67,68 Future research is required to examine whether the capacity of the EHR to improve the overall care delivery process of patients will likely outweigh the barrier associated with the additional time required to use the system. New methods to measure the impact of the EHR on time efficiency from an organization's or a system's perspective will have to be developed. Further research is needed to examine the impact of EHR on system efficiency and how this will influence adoption rates by all users, particularly physicians.

12. FUTURE SCOPE:

Widespread adoption of electronic health records offers an unprecedented opportunity to apply informatics techniques to clinical and operational data.1, 2 Although the electronic health record stores a wealth of clinical data that can potentially improve the quality of clinical emergency department (ED) care,1, 2, 3, 4 this information is often lost in the sea of data collected.

Materials and Methods:

Consistent with previously published reviews of clinical decision support in the general medical literature, we defined a clinical decision support as any software designed to directly aid in clinical decisionmaking in which characteristics of individual patients are matched to a

Limitations:

As in all systematic reviews, decisions made in regard to inclusion and exclusion criteria influenced our sample. Given the volume of literature and the motivation for our study, we chose to focus only on computerized decision support integrated with electronic health record technology. Although this limitation was useful in defining a more cohesive cohort of studies, a few recent, high-quality studies involving clinical decision support tools that were not integrated into an electronic health.

APPENDEX:

SURVEY DEVELOPMENT:

The survey was developed by the investigators, with guidance from a consensus panel of experts in the fields of survey research, health-information technology, and health care management and policy and from representatives of hospital and physician groups and organizations.

SURVEY SAMPLE:

- We identified all U.S. physicians who provide direct patient care from the 2007 Physician Masterfile of the American Medical Association (AMA). We excluded all doctors of osteopathy, residents, physicians working in federally owned hospitals, those with no listed address, those who requested not to be contacted, and those who were retired. From the resulting list, we randomly selected 5000 physicians for inclusion in the sample.

- Of these 5000 physicians, 516 were ineligible to participate in the survey because they were deceased, retired, out of the country, practicing in a specialty that was not included in the survey (i.e., radiology, anesthesiology, pathology, or psychiatry), had no known address, or were not providing care to patients. Of the 4484 eligible respondents, 2758 completed the survey, which yielded a response rate of 62%. A copy of the survey appears in the **Supplementary Appendix**, available with the full text of this article at www.nejm.org.

Results:

Among all respondents, the factors that were most frequently cited as facilitators of adoption were financial incentives for the purchase (55% among physicians with no electronic health records and 46% among those with electronic health records, P=0.001) and payment for use of an electronic-records system (57% and 52%, respectively; P=0.04). About 40% of respondents with and without an electronic-records system also reported that protecting physicians from personal liability for record tampering by external parties could be a major facilitator of adoption.

Source Code:

A full range of stakeholders participated in developing the CODE-EHR framework, including regulators (US Food and Drug Administration and European Medicines Agency), governmental agencies (European Commission, the UK National Institute for Health and Care Excellence, and Innovative Medicines Initiative), medical journals (*The BMJ*, *European Heart Journal*, *The Lancet*, and *The Lancet Digital Health*), patient advocacy groups (European Heart Network and ESC Patient Forum), representatives from the pharmaceutical industry, health-care payers, academic institutions, and professional societies.

Structured health-care data to improved patient care:

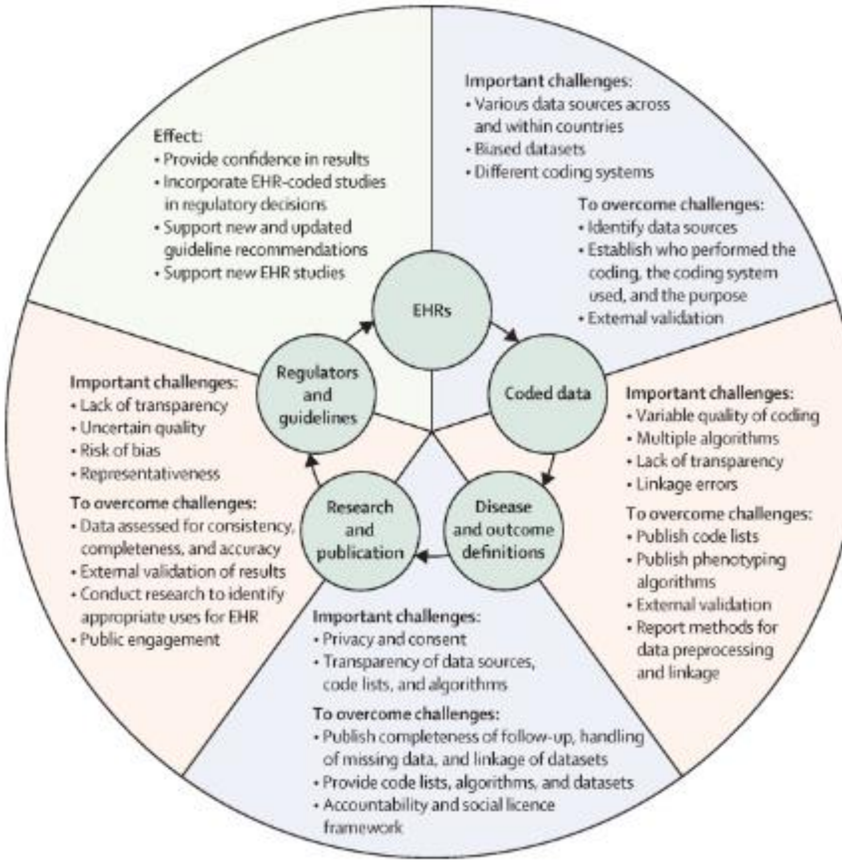


Figure 1 From structured health-care data to improved patient care