Digital Transformation; Unified Card's Health Records Development

Hussam Elbehiery[1], Khaled Elbehiery[2]

[1]Computer Science Department, October 6 University (O6U), Egypt
[2]Computer Information Systems Department, Park University, USA

Abstract — *Health care providers resort to informal temporary practices known as workarounds for handling exceptions to normal workflow imposed by health record systems (EHRs\EMRs). Workarounds may seem favorable at first sight, but it could jeopardize the patient safety and the efficiency of the care. Therefore, the use of information technology in our daily lives has been on the rise. Digital health services and technologies are changing the way in which healthcare is provided and experienced worldwide. This change brings some countries significant health system efficiencies and clinical benefits, including improvements in the management of clinical risk and patient safety. Conversely, constant vigilance of our broader digital health system is required, supported through a safety culture and governance structures to maintain oversight and management of unique safety and quality challenges of using a digital healthcare system. These challenges could go beyond technology and impact the whole system, so, Identification is crucial aspect to guarantee an efficient and effective delivery of health services and public health management, that leads to achieving Sustainable Development Goal (SDG).*

This paper provides insight into the effects of EHR\EMR workarounds on organizational workflows and outcomes of care services. Also, it highlights the key areas where foundational identification could be leveraged to improve healthcare outcomes for the patients, providers, and the government agencies, that in turn reinforces the identification system as a whole. However, it is also important to recognize that there are risks come with it such as challenges in planning, implementing, and integration, in particular, this includes ensuring that foundational systems are robust, inclusive, and that there are sufficient measures in place for the confidentiality and security of the personal data.

Keywords — *EHR, EMR, National Identity ID, Unified Card, BioBanks, Quarantine areas, Medical convoys, Intelligent Therapy Decision Support, AAA, COVID-19.*

I. INTRODUCTION

Technology is no longer something separate from our everyday lives, but instead, it is something ubiquitous like the air we breathe. There is perhaps no better use of technology than improving the way we deliver medical care by examining the possible transformations across every sector of the healthcare industry, along with few challenges and the proposed solutions. Interoperability is one of the biggest bridges yet to cross efficiently among doctors, patients, and hospitals, as a result of that, technology must improve the way our devices and systems communicate to guide the healthcare and medical technology toward this overarching goal. As medical records become increasingly digitized, the development of a comprehensive, secure health information exchange (HIE) will provide the healthcare community data needed to identify trends, trace the efficacy of new treatments and medications, share successes, collaborate, and improve healthcare for all.

This paper discusses the differences between the EHR and EMR, the national identity cards, the unicard project, and biobanks information reinforcement. The paper also covers Quarantine areas, Medical convoys, the Intelligent Therapy Decision Support. The main objectives of the paper are the advantages of linking the EHR/EMR to National Identity ID, in addition to Authentication, Authorization, and the Accounting (AAA) processes of this integrated system.

II. EMR VS. EHR

Some people use the terms “Electronic Medical Record” and “Electronic Health Record” (or “EMR” and “EHR”) interchangeably, but here at the Office of the National Coordinator for health information technology (ONC), you’ll notice we use electronic health record or EHR almost exclusively. While it may seem a little picky at first, the difference between the two terms is actually quite significant. The EMR term came along first, and indeed, early EMRs were “medical.” They were for use by clinicians mostly for diagnosis and treatment. In contrast, “health” relates to “The condition of being sound in body, mind, or spirit; especially…freedom from physical disease or pain…the general condition of the body.” The word “health” covers a lot more territory than the word “medical.” And EHRs go a lot further than EMRs.

Electronic Medical Records (EMRs) are a digital version of the paper charts in the clinician’s office. An EMR contains the medical and treatment history of the patients in one practice. EMRs have advantages over paper records. For example, EMRs allow clinicians to:

- Track data over time
- Easily identify which patients are due for preventive screenings or checkups
- Check how their patients are doing on certain parameters—such as blood pressure readings or vaccinations
- Monitor and improve overall quality of care within the practice

But the information in EMRs doesn't travel easily out of the practice. In fact, the patient's record might even have to be printed out and delivered by mail to specialists and other members of the care team. In that regard, EMRs are not much better than a paper record.

Electronic Health Records (EHRs) do all those things—and more. EHRs focus on the total health of the patient—going beyond standard clinical data collected in the provider's office and inclusive of a broader view on a patient's care. EHRs are designed to reach out beyond the health organization that originally collects and compiles the information. They are built to share information with other health care providers, such as laboratories and specialists, so they contain information from all the clinicians involved in the patient's care. The National Alliance for Health Information Technology stated that EHR data "can be created, managed, and consulted by authorized clinicians and staff across more than one healthcare organization."

The information moves with the patient—to the specialist, the hospital, the nursing home, the next state or even across the country. In comparing the differences between record types, HIMSS Analytics stated that, "The EHR represents the ability to easily share medical information among stakeholders and to have a patient's information follow him or her through the various modalities of care engaged by that individual." EHRs are designed to be accessed by all people involved in the patients care—including the patients themselves. Indeed, that is an explicit expectation in the Stage 1 definition of "meaningful use" of EHRs (See Figure 1).

And that makes all the difference. Because when information is shared in a secure way, it becomes more powerful. Health care is a team effort, and shared information supports that effort. After all, much of the value derived from the health care delivery system results from the effective communication of information from one party to another and, ultimately, the ability of multiple parties to engage in interactive communication of information [1].

Fig 1: Integration of Health data from a participating collection of Systems for a single patient using the EHR

A block diagram of multiple-source-data systems that contribute patient data ultimately reside in a CPR as shown in Figure 2. The database interface, commonly called an interface engine, may perform a number of functions. It may simply be a router of information to the central database. Alternatively, it may provide more intelligent filtering, translating, and alerting functions [3] and [4].

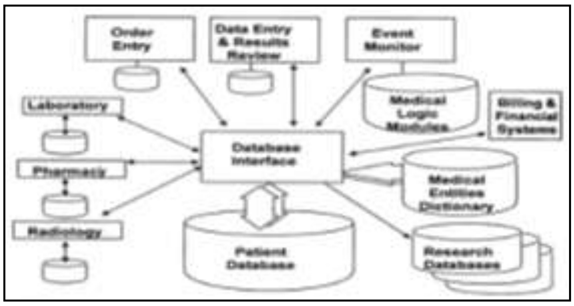

Fig 2: Database Interface

A. Electronic Records' Benefits

Both EHRs and EMRs offer benefits to patients and healthcare providers:

- With fast, accurate and updated information, medical errors are reduced and health care is improved.
- Patient charts are more complete and clearer – no more deciphering illegible scribbles.
- Information sharing can reduce duplicate testing, saving patients and providers time, money and trouble.
- Improved information access makes prescribing medication safer and more reliable.
- Promoting patient participation can encourage healthier lifestyles and more frequent use of preventative care.
- More complete information means more accurate diagnoses.

Electronic records are expected to make healthcare more efficient and less costly, making the switch a good investment for our nation's healthcare [2].

B. Benefits of EHRs

With fully functional EHRs, all members of the team have ready access to the latest information allowing for more coordinated, patient-centered care [1]. With EHRs:

- The information gathered by the primary care provider tells the emergency department clinician about the patient's life-threatening allergy, so that care can be adjusted appropriately, even if the patient is unconscious.
- A patient can log on to his own record and see the trend of the lab results over the last year, which can help motivate him to take his medications and keep up with the lifestyle changes that have improved the numbers.
- The lab results run last week are already in the record to tell the specialist what she needs to know without running duplicate tests.
- The clinician's notes from the patient's hospital stay can help inform the discharge instructions and follow-up care and enable the patient to move from one care setting to another more smoothly.

III. THE VIRTUAL CARE AND EHR

In the scramble to take advantage of federal incentives for implementing Electronic Health Records (EHRs), many hospitals and physician practices did not effectively integrate virtual care into EHR design. But now many providers are insisting that the two should be united. Here are some of the compelling benefits:

- **Eliminating extra steps in documenting care** – An integrated system creates a full record of virtual care consultations and improves care coordination.
- **Minimizing duplicate records** – Integrating virtual care and EHR data streamlines record collection and makes it faster and easier to find patient data.
- **Improved workflow and user experience** – When a virtual care session can be launched from within an EHR record, it simplifies the user experience and saves physicians time. Large hospital systems like Nemours Children's Health have found that EHR/virtual care integration leads to an increase in physician adoption of telehealth.
- **Better reporting and revenue tracking** – Anything that's documented outside a hospital's EHR can be difficult to track. When virtual care is integrated into the EHR, all clinical and billing data is in one place, which makes reporting and reconciliation far easier.
- **Better care and outcomes** – One Southeastern hospital recently used its integrated virtual care/EHR system to more effectively deal with a whooping cough outbreak in its service area.

The stampede to implement EHRs is over because nearly every hospital has one. Now comes the tricky-yet-rewarding part: fully integrating virtual care consultations into EHR data collection and workflow [5].

IV. EMR AND BIOBANKS

Electronic medical records (EMRs) allow storage, retrieval and modification of medical records using digital media instead of paper-based records systems. EMRs include databases of patient demographic data, clinical laboratory results, radiology images and pharmaceutical records, as well as patient diagnosis, treatment, disease progression and survival data.

The potential of personalized medicine will be realized when genomic data, environmental exposures and family medical history are added to these databases. Since genome-wide approaches using high-throughput technology are replacing conventional methodologies in "omics", entire genomic sequences will soon be linked via EMRs to clinical and demographic data. To reach this objective, several health organizations have constructed large data and specimen bio-repositories.

The PopGen Biobank (University Hospital of Kiel, Germany) is one example of a successful European bio-repository involving more than 100 scientific and 50 medical partners. This biobank holds specimens from 45 000 participants in an effort to investigate genetic risk factors associated with complex diseases, and, like other biobanks, could potentially be used for pharmacogenetic research [6].

V. EMR CONCERNS

All of the facilities and physicians in hospitals or Clinical organizations use electronic medical record (EMR) systems, and all were left scrambling to function when their system crashed. If multiple hospitals use the same system, the scale of the problem is even larger when an outage occurs. "A computer system lets you do and control more things at once," says Dean Sittig, a professor in the School of Biomedical Informatics at the University of Texas Health Science Center at Houston. "But when it goes down, you can have bigger accidents."

The problem was traced back to a single faulty computer server. During a downtime, many activities become much more difficult. For example, hospitals get backed up because patients can't be registered or discharged. Communication between departments becomes difficult, as does ordering medication and getting test results back from labs. Perhaps the most difficult task to perform well is billing for all services rendered. When using a backup paper system, a lot of the little things that usually enter the system with a touch of a button go unrecorded, says Sittig. If the EMR system outrage affects many hospitals, each with hundreds of patients, that can add up rather quickly. "A lot of people have estimated that it can cost up to a million dollars an hour in lost charges," says Sittig.

There are a number of safeguards, however, that can help prevent system failures. And there are practices to mitigate the effects of a crash if those safeguards eventually prove inadequate. When the EMR systems are standalone inside each hospital or a healthy organization, and these systems go down, you are then able to go back and reinstall all the patient and system data so you can get back up and running.

So, the solution is to run the system in the cloud and linking by another system uses the same information or part of them like unicard systems. but on the other hand, the primary issue to address is potential connectivity problems and ensuring the connection to the system remains uninterrupted if you connect over the Internet. However, there is still plenty of room for improvement in creating robust and reliable EMR systems. Now is the time in adopting sophisticated electronic systems compared to other sectors, such as the financial industry. It stands to reason that health care providers should adopting the best strategies. “Downtime is not an option for them,” says Sittig. “We are talking about millions of dollars per second” [7].

VI. EHR/EMR AND BLOOD TYPES

Blood type tests are done before a person gets a blood transfusion and to check a pregnant woman's blood type. Human blood is typed by certain markers (called antigens) on the surface of red blood cells. Blood type may also be done to see if two people are likely to be blood relatives. The most important antigens are blood group antigens (ABO) and the Rh antigen, which is either present (positive, +) or absent (negative, -). So, the two most common blood type tests are the ABO and Rh tests.

Blood received in a transfusion must have the same antigens as yours (compatible blood). If you get a transfusion that has different antigens (incompatible blood), the antibodies in your plasma will destroy the donor blood cells. This is called a transfusion reaction, and it occurs immediately when incompatible blood is transfused. A transfusion reaction can be mild or cause a serious illness and even death. A blood type test is done [8]:

- Before a person gets a blood transfusion.
- Before a person donates blood.
- Before a person donates an organ for transplantation.
- Before surgery.
- When a woman is planning to become pregnant or first becomes pregnant.
- To show whether two people could be blood relatives.
- To check the identify of a person suspected of committing a crime.

You may have a mild allergic reaction even if you get the correct blood type. Signs of a reaction include [9]:

- A fever.
- Hives.
- Shortness of breath.
- Pain.
- Fast heart rate.
- Chills.
- Low blood pressure.

Shareability with other country organizations is the greatest strength and benefit of electronic health records. On-demand access to patients’ EHRs helps inform decisions and coordinate care—benefitting both providers and their patients or all the people. EHRs make it possible for healthcare providers and practitioners to transfer data quickly and securely. Data can be shared with the unicard organizational systems to be overall the countries not for specific hospitals especially in blood types which cause huge problems due to the delay processes related or insufficiency problems [10].

VII. EHR/EMR QUARANTINE AREAS

Isolation is defined as the separation of persons with communicable diseases from those who are healthy. This public health practice, along with quarantine, is used to limit the transmission of infectious diseases. It is clear now that isolation of patients and staff interrupts the transmission of disease. Today, we find smaller outbreaks of microorganisms that have acquired substantial resistance to antimicrobial agents [11].

Isolation and quarantine are public health practices used to stop or limit the spread of disease. **Isolation** is used to separate **ill** persons who have a communicable disease from those who are healthy. Isolation restricts the movement of ill persons to help stop the spread of certain diseases. **Quarantine** is used to separate and restrict the movement of **well** persons who may have been exposed to a communicable disease to see if they become ill. These people may have been exposed to a disease and do not know it, or they may have the disease but do not show symptoms. Quarantine can also help limit the spread of communicable disease. Isolation and quarantine are used to protect the public by preventing exposure to infected persons or to persons who may be infected [12].

As we could make the linkage between the EMR files and the governmental organization files using as example the unicard systems, that will ensure that quarantine measures are ethically and scientifically sound [13]:

- Use the least restrictive means available to control disease in the community while protecting individual rights Without bias against any class or category of patients.
- Advocate for the highest possible level of confidentiality when personal health information is transmitted in the context of public health reporting.
- Advocate for access to public health services to ensure timely detection of risks and

implementation of public health interventions, including quarantine and isolation.

- Advocate for protective and preventive measures for physicians and others caring for patients with communicable disease.
- Develop educational materials and programs about quarantine and isolation as public health interventions for patients and the public.

VIII. EHR\EMR AND MEDICAL CONVOYS

The medical convoys are considered the gate of the university to the community and the surrounding environment; where there is an intellectual and scientific cohesion between them, the thing which promises prospective value. Acquainting the community with the role of the university to perform its mission in serving the community and developing the environment in its various fields. The community benefits from specialized academic competencies in all medical fields and solves the problems of the environment directly. Directing the applied scientific research to solve the problems of the society scientifically and realistically through experiments and actual practice.

The students in the final stages of the Bachelor's degree receive scientific training and academic studies application on campus and in the university laboratories which result in their interaction with the surrounding environment, remote communities of the homeland, rural areas and urban slums. Training the students, faculty members and their assistants to work as a team to cope with the international scientific progress that is common in other countries of the world. Forming an operating system that works in accordance with the systems, procedures and fixed rules of applied research groups who work on solving the problems of the community and interact with it, and also will be linked to the governmental organization systems like the unicard systems [14].

IX. EHR\EMR AND UNICARD SYSTEM LINKAGE

Rationales were associated with work system components (persons, technology and tools, tasks, organization, and physical environment) of the Systems Engineering Initiative for Patient Safety (SEIPS) framework to reveal their source of origin as well as to determine the scope and the impact of each EHR workaround from a structure-process-outcome perspective.

The EHR\EMR is an integrated suite of health care software. Its applications support functions related to patient care and management, registration and scheduling, clinical systems for health care providers, ancillary laboratory, pharmacy and radiology systems, and a billing system. The following sections in the EHR\EMR linkage with unicard governmental systems address the data collection phases (I and II) and data analysis phases (III, IV, V, and VI) in greater detail as illustrated in Figure 3 [15].

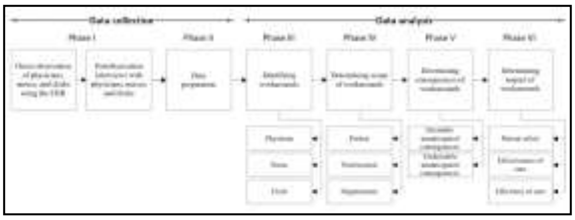

Fig 3: Illustration of the 6 phases of linkage method

A. Clinical Governance Framework at a glance

The Framework describes the requirement for people, systems, structures and processes that support the development of safe and high-quality products, services and infrastructure. It focusses on working together with co-production and user centered design approaches throughout the development lifecycle to deliver the organizations work with high standards of safety and quality. Key functional components of the Agency's Clinical Governance systems and processes are described within the framework, and required for its successful implementation. These include [16]:

- The Agency's Clinical Governance Principles
- Committee structures relating to quality and safety
- Policies and procedures relating to quality and safety
- Risk management processes to guide the development of products and services
- Incident management and external assurance processes
- Processes to support a culture of organizational safety
- Performance monitoring and reporting for the Agency relating to quality and safety

B. Clinical risks in Digital Health

The Framework recognizes that while digital enablement provides the opportunity for significant safety benefits, the possibility exists for a number of unintended clinical risks to emerge. Some of these clinical risks are well understood and are inherited from paper-based healthcare records. Summarized below are the key clinical risks identified through prospective analysis of digital health products and infrastructure [16].

- **Misidentification** – identity management errors in source systems and workflows that in turn lead to mismatches of individual health care identifiers (IHI) with clinical information. MHR design requires the IHI as the unique key for uploading information to the MHR system.
- **Loss of information** – information may not be uploaded successfully on account of failing technical validations.
- **Incorrect information** – the information uploaded to the digital health record from the source system may be incorrect or ambiguous.
- **Human error** – clinical staff may use systems in good faith, however, inadvertently not detect

that they are contributing to inaccuracies in clinical content.

- **Expired authentication certificates** – which prevents the uploading of clinical documents to a patient's MHR.

X. EHR\EMR AND AI

Electronic health record systems for large, integrated healthcare delivery networks today are often viewed as monolithic, inflexible, difficult to use and costly to configure. They are almost always obtained from commercial vendors and require considerable time, money, and consulting assistance to implement, support and optimize. For improving this misalignment between systems and processes are limited is using AI to make existing EHR\EMR systems more flexible and intelligent. Some delivery networks, sometimes in collaboration with their EHR\EMR platform vendor, are making strides in this direction. AI capabilities for EHRs\EMRs are currently relatively narrow but we can expect them to rapidly improve. They include:

- Data extraction from free text
- Diagnostic and/or predictive algorithms
- Clinical documentation and data entry
- Clinical decision support

Amazon Web Services recently announced a cloud-based service that uses AI to extract and index data from clinical notes. While AI is being applied in EHR\EMR systems principally to improve data discovery and extraction and personalize treatment recommendations, it has great potential to make EHRs\EMRs more user friendly. This is a critical goal, as EHRs\EMRs are complicated and hard to use and are often cited as contributing to clinician burnout. Today, customizing EHRs\EMRs to make them easier for clinicians is largely a manual process, and the systems' rigidity is a real obstacle to improvement. AI, and machine learning specifically, could help EHRs\EMRs continuously adapt to users' preferences, improving both clinical outcomes and clinicians' quality of life. However, all of these capabilities need to be tightly integrated with EHRs\EMRs to be effective. Most current AI options are "encapsulated" as standalone offerings and don't provide as much value as integrated ones, and require time-pressed physicians to learn how to use new interfaces. But mainstream EHR\EMR vendors are beginning to add AI capabilities to make their systems easier to use. Firms like Epic, Cerner, Allscripts, and Athena are adding capabilities like natural language processing, machine learning for clinical decision support, integration with telehealth technologies and automated imaging analysis. This will provide integrated interfaces, access to data held within the systems, and multiple other benefits — though it will probably happen slowly.

Future EHRs\EMRs should also be developed with the integration of telehealth technologies in mind (as is the EHR\EMR at One Medical). As healthcare costs rise and new healthcare delivery methods are tested, home devices such as glucometers or blood pressure cuffs that automatically measure and send results from the patient's home to the EHR\EMR are gaining momentum. Some companies even have more advanced devices such as the smart t-shirts of Hexoskin, which can measure several cardiovascular metrics and are being used in clinical studies and at-home disease monitoring. Electronic patient reported outcomes and personal health records are also being leveraged more and more as providers emphasize the importance of patient centered care and self-disease management; all of these data sources are most useful when they can be integrated into the existing EHR\EMR [17].

The impact of AI-driven applications on health care is challenged with various limitations. Key issues around the safety of AI in health care and steps to extenuate the same are listed in Table 1. These issues are likely to arise at various stages of deployment of AI.

Table 1. Safety Issues for Artificial Intelligence (AI) in Health Care

Safety Issue	Elements of Hazard	Key Steps to Mitigation
Distributional shift	Out-of-sample predictions	- Training of AI systems with large and diverse data sets
Quality of data sets	Poor definition of outcomes No representative data sets	- Build more inclusive training algorithms using balanced data sets, correctly labeled for outcomes of interest
Oblivious impact	High rates of false-positive and false-negative outcomes	- Include outliers in training data sets - Enable systems to adjust for confidence levels Sustained and repeated use of AI algorithms - Transparent and easily accessible AI algorithms
Confidence of prediction	Uncertainty of predictions Automation complacency	- Sustained and repeated use of AI algorithms - Transparent and easily accessible AI algorithms
Unexpected behaviors	Calibration drifts	- Design and train systems to learn and unlearn and have more predictable behavior
Privacy and anonymity	Identification of patient data	- Define layers of security and rules for data privacy
Ethics and regulations	Poor ethical standards and regulatory control for development and deployment of AI	- Anonymize data before sharing

Whereas Table 1 provides some elements of hazards and mitigation strategies, Figure 4 shows the linkage of AI-based applications and safety issues. The following sections will discuss each safety issue further.

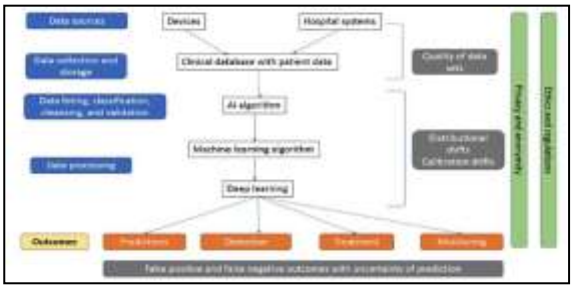

Fig 4: Safety concerns at various stages of deployment of artificial intelligence (AI)

Training is needed not only for AI-based systems but also for clinicians, who can be groomed as information specialists to further train and develop accurate and dependable AI solutions. AI-augmented clinicians should be more efficient and confident and not faced with the uncertainty of risks associated with technical advances in medicine. Physicians should understand, develop, adopt, and leverage AI to improve patient care [18].

XI. LINKING THE EHR/EMR TO NATIONAL IDENTITY ID (UNICARD)

A. Linkage Algorithms

Data come in different shapes, sizes, and quality, creating scenarios that must be considered in building a linkage algorithm. For instance, demographic information often contains typographical and data entry errors, such as transposed Social Security Number (SSN) digits and misspellings. An individual's information sometimes changes over time, with life changes such as marriage or moving leading to changes in one's name or address. People sometimes deliberately report false information to defraud insurance providers or to avoid detection. Twins can have very similar information. Finally, the spouses and/or children of the family's primary health insurance subscriber sometimes use the primary subscriber's information. These idiosyncrasies are what make data linkage difficult, so the more work done upfront to clean and standardize the data, the better the chances of a successful linkage.

With this in mind, the first step after data delivery is to examine the nature of the data, paying particular attention to the way information is stored, the completeness of the identifying information, the extent to which information overlaps, and the presence of any idiosyncrasies in the data. By doing so, steps can be taken to clean and standardize the available information across data sources to minimize false matches attributable to typographical errors.

Many data manipulation techniques are available in commonly used software (e.g., SAS and Stata) to facilitate the data cleaning and standardization process. Using these techniques renders all linkage variables the same across data sources—that is, variables that will be compared are forced into the same case (e.g., all uppercase), the same format (e.g., 01SEP2013), the same content (e.g., stripped of all punctuation and digits), and the same length.

Additionally, identifiers can be parsed into separate pieces of information. For instance, full names can be parsed into first, middle, last, and maiden names; dates of birth can be parsed into month, day, and year of birth; and addresses can be parsed into street, city, State, and ZIP Code. Parsing identifiers into separate pieces where possible allows the researcher to maximize the amount of available information and give credit for partial agreement when record pairs do not agree character for character. This is particularly important in accounting for changes across time, such as a name change after marriage or an address change after a move. In such cases, matching on the separate pieces allows for the possibility of partial credit that, when combined with other information, may provide sufficient evidence that the records being compared represent the same person.

Finally, it is important to consider informational overlap in the available linkage identifiers. As in statistical modeling, where two strongly correlated variables should not be included together in the model, variables with overlapping information should not be included in the same linkage algorithm. In such cases, assigning credit for matches on both variables (e.g., ZIP Code and county) is redundant, leading to an overestimate of the extent to which two records agree. Similarly, assigning separate penalties for nonmatches on overlapping variables (e.g., first name and first name initial) is redundant, leading to an overestimate of the extent to which two records disagree. In the case of overlapping variables, researchers can pick either one or take the most informative match; for example, if two records match on ZIP Code and county, then the match on ZIP Code is more informative.

There are two main types of linkage algorithms: deterministic and probabilistic. Choosing the best algorithm to use in a given situation depends on many interacting factors, such as time; resources; the research question; and the quantity and quality of the variables available to link, including the degree to which they individually and collectively are able to identify an individual uniquely. With this in mind, it is important that researchers be equipped with data linkage algorithms for varying scenarios. The key is to develop algorithms to extract and make use of enough meaningful information to make sound decisions.

- **Deterministic algorithms** determine whether record pairs agree or disagree on a given set of identifiers, where agreement on a given identifier is assessed as a discrete—"all-or-nothing"—outcome. Match status can be assessed in a single step or in multiple steps. The deterministic approach ignores the fact that certain identifiers or certain values have more discriminatory power than others do.
- **Probabilistic strategies** have been developed to assess (1) the discriminatory power of each identifier and (2) the likelihood that two records are a true match based on whether they agree or disagree on the various identifiers.

Both deterministic procedures and probabilistic procedures should be considered iterative. After completing the initial linkage, a random sample of match decisions should be reviewed to ensure that the algorithm is performing as intended. If the review process reveals opportunities for improvement, then the algorithm should be adjusted to account for the identified weaknesses. Once the linkage process is complete, the results should be compared to known metrics [20].

B. Unicard Linkage with EHR\MHR

Electronic health care data are increasingly being generated and linked across multiple systems, including electronic and medical health records (EHRs\EMRs), patient registries, and claims databases. In general, every system assigns its own identifier to each patient whose data it maintains. This makes it difficult to track patients across multiple systems and identify duplicate patients when different systems are linked. Efforts to address this challenge are complicated by the need to protect patient privacy and security.

Patient identity management (PIM) has been defined as the "ability to ascertain a distinct, unique identity for an individual (a patient), as expressed by an identifier that is unique within the scope of the exchange network, given characteristics about that individual such as his or her name, date of birth, gender [etc.]."

The need for PIM strategies in the realm of health care data is rising, primarily because of the continued increase in the quantity and linkage of electronic health care data. The quantity of electronic health care data continues to grow. EHRs\EMRs are increasingly being used to generate electronic health care data.

As more electronic health care data are generated and linked together, PIM has become crucial in order to (1) enable health record document consumers to obtain trusted views of their patient subjects, (2) facilitate data linkage projects, (3) abide by the current regulations concerning patient information–related transparency, privacy, disclosure, handling, and documentation, and (4) make the most efficient use of limited health care resources by reducing redundant data collection.

The challenge of PIM is not a new one, and it has existed since health care information was first digitized. In general, PIM is conducted in one of two environments: either shared identifiers are present or they are absent. When shared identifiers exist, the main PIM strategy that has emerged is to assign a unique patient identifier (UPI) to each patient. In situations where shared identifiers do not exist, the most common PIM strategy is to use patient-matching algorithms to determine whether two sets of information belong to separate patients or the same patient.

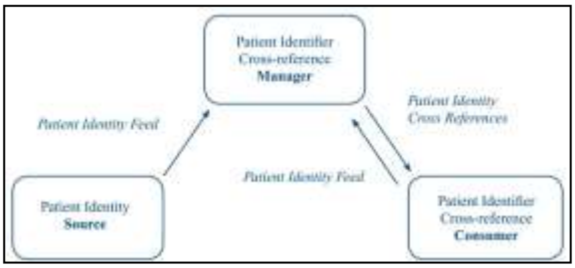

Fig 5: Basic process flow with patient identifier cross-referencing

Recently, interest has increased in expanding the use of existing administrative identifiers (such as the Social Security number in the United States) to serve as UPIs in the health care arena. In 2009, the U.S.–based nonprofit Global Patient Identifiers proposed the Voluntary Universal Healthcare Identifier project, which aims to make unique health care identifiers available to any patient who uses the services of a regional health information organization or health information exchange (HIE). Any statistical matching approach is dependent on three factors [19]:

- **The quality of the data it is comparing:** Are the data entered correctly, without mistakes? Are the data complete, or is there a high level of missing data? The quality of data within a particular registry will always be a factor of the practices employed by that registry.
- **The comparability of the data it is comparing:** Are the data from the different sources collected in the same format and in the same way? There are a number of current initiatives to improve the standardization of data elements being used in patient registries, but the area with the most need for future work is the testing and standardization of the algorithms themselves.
- **The accuracy of the matching algorithm:** What is the likelihood of the algorithm returning a false positive match or missing true matches? While there has been some scientific research validating specific matching algorithms.

As an alternative to creating a health-specific functional identification system, some countries have instead opted to use existing foundational identification systems, such as population registers, unique identification numbers (UINs) or national ID (NID) cards, as the basis for patient identification, verification, and authentication. Leveraging a foundational system in this way may create additional benefits beyond those offered by a functional system. While some countries have opted to create stand-alone, functional identification systems for these purposes, others have instead chosen to integrate an existing foundational identification system—e.g., using national ID cards or unique ID numbers—into their healthcare systems. In addition to the general benefits of digital patient identification, using a foundational identification system to underpin EHRs\EMRs, insurance benefits, and health data exchange offers three potential advantages over a typical, health-specific functional system [21]:

- Increased efficiency in the identity ecosystem
- Opportunities for interoperability
- Mutual reinforcement of identification systems

XII. AAA SECURITY

The privacy of patients and the security of their information is the most imperative barrier to entry when considering the adoption of electronic health records in the healthcare industry. The most frequently mentioned security measures and techniques are categorized into three themes: administrative, physical, and technical safeguards. The sensitive nature of the information contained within electronic health records has prompted the need for advanced security techniques that are able to put these worries at ease. It is imperative for security techniques to cover the vast threats that are present across the three pillars of healthcare.

Health records (EHRs\EMRs) incorporate a vast amount of patient information and diagnostic data, most of which is considered protected health information. With the advancement of technology, the emergence of advanced cyber threats has escalated, which hinders the privacy and security of health information systems such as EHRs\EMRs. Privacy and Security concerns present the largest and most important barrier to adopting EHRs\EMRs. While there are numerous security techniques that could be implemented to prevent unauthorized access to electronic health records, it is difficult to say with confidence what techniques should and should not be used, depending on the size and scope of a healthcare organization. This manuscript identified firewall categories and cryptography methodologies, in addition to a handful of other security techniques. These methods proved to be the most promising and successful techniques for ensuring privacy and security of EHRs\EMRs, as well as the protected health information contained [22].

The administrator can take an access to a router or a device through console but it is very inconvenient if he is sitting far from the place of that device. Therefore, eventually he has to take remote access to that device. However, as the remote access will be available by using an IP address therefore it is possible that an unauthorized user can take access using that same IP address therefore for security measures, we have to put authentication. In addition, the packets exchange between the device should be encrypted so that any other person should not be able to capture that sensitive information. Therefore, a framework called AAA is used to provide that extra level of security. AAA is a standard based framework used to control who is permitted to use network resources (through authentication), what they are authorized to do (through authorization) and capture the actions performed while accessing the network (through accounting) [23].

AAA security enables mobile and dynamic security. Without AAA security, a network must be statically configured in order to control access. IP addresses must be fixed, systems cannot move, and connectivity options must be well defined. The proliferation of mobile devices and the diverse network of consumers with their varied network access methods generates a great demand for AAA security. AAA security is designed to enable you to dynamically configure the type of authorization and authentication you want by creating a method list for specific services and interfaces. AAA security means increased flexibility and control over access configuration and scalability, access to standardized authentication methods such as RADIUS, TACACS+, and Kerberos, and use of multiple backup systems. The increase of security breaches such as identity theft, indicate that it is crucial to have sound practices in place for authenticating authorized users in order to mitigate network and software security threats [24].

XIII. ID CARDS AND COVID-19: WHAT YOU NEED TO KNOW

United Nations launched the UN Legal Identity Agenda in June 2019 and it was officially endorsed in March 2020. It builds on the existing international methodological framework on civil registration and vital statistics and consists of a holistic approach to civil registration, vital statistics and identity management. The UN Legal Identity Task Force, co-chaired by the UN Statistics Division/DESA, UNDP and UNICEF, and with UNECA and UNESCAP spearheading the implementation of UN LIA in their respective regions, is launching a short survey in order to assess the impact of the COVID-19 pandemic on the functioning of civil registration worldwide, provide an information regarding national solutions and a forum for exchange of experiences.

Based on the replies from the countries, recommendations for civil registration authorities are issued by the United Nations Legal Identity Agenda Task Force with the support of, and contributions by, UNECA, UNESCAP and SPC, to ensure operational continuity during COVID-19 and allow for the continued production of comprehensive vital statistics [26].

In many countries, digital ID system has enabled the remote application and processing of urgently needed national IDs despite the halting of physical credential issuance to abide by social distancing and isolation measures. "At the end of last year, Argentina was the first country in the world to offer its citizens, together with the physical ID, a true national identity credential within a mobile app, putting the Renaper institution at the forefront of innovation worldwide."

Now the governments are moving a step forward by providing mobile ID's to their citizens while the Physical ID issuance has stopped during the global health crisis. Once again, a great example of how Governments and mobile IDs can help the world keep turning.

Last year Argentina provides its citizens with a national digital ID within a mobile app. A request for a mobile ID could be filed at an official office. Citizens would then receive an email code to activate the digital DNI (National Identity Document) [27].

Fig6: Argentina enables remote digital ID processing for mobile during COVID-19 crisis

XIV. CONCLUSION

Electronic Medical Records store and manage a huge amount of clinical data, new approaches are needed in order to achieve higher performance and to store this data efficiently than the current system that is utilizing the traditional relational databases [6]. Medical faults, human errors, and injured patients always existed and, unfortunately, most probably always will exist, but the recognition of this fact does not prevent the search for new methods and mechanisms aimed to combat and avoid them all. The EHR\EMR linkage with the unicard system intends precisely to achieve this goal offering a better design and performance, better training for the users, and providing a clear definition of protocols and guidelines to serve organize this effort [25].

The investment demands quantifying benefits to enable measurement, building trust for adoption of AI that enables value-based and patient-centric health care, building and enhancing technical skills, and organizing a system of governance. Data protection legislation should be formulated and strengthened for the collection and processing of data in clinical research. Quality standards for AI applications in medicine should be clearly defined to add value, accuracy, efficiency, and satisfaction to the healthcare system.

ACKNOWLEDGMENT

The authors would like to thank ***October 6 University (O6U)***, ***Egypt*** and ***Park University***, ***USA*** for their support to introduce this research paper in a suitable view and as a useful material for researchers. The authors also would like to thank their colleagues who provided insight and expertise that greatly assisted the research.

REFERENCES

[1] Peter Garrett and Joshua Seidma, "*EMR vs EHR – What is the Difference?*," The office of the National Coordinator for the Health Information Technology, Health IT Buzz, Electronic Health & Medical Records, USA.gov, January 4, 2011. [Online] Available: https://www.healthit.gov/buzz-blog/electronic-health-and-medical-records/emr-vs-ehr-difference

[2] USF Health online, "Differences Between EHR and EMR." [Online] Available:https://www.usfhealthonline.com/resources/key-concepts/ehr-vs-emr/

[3] Awatef Hassan kassem, and Gamal Helmy, "Medical Records," Mansoura University, 2019, Egypt. [Online] Available: http://www.mohp.gov.eg/theducation/Second-Fany-Tsgeeltbeey/%D8%A7%D9%84%D8%B3%D8%AC%D9%84%D8%A7%D8%AA%20%D8%A7%D9%84%D8%B7%D8%A8%D9%8A%D8%A9.pdf

[4] "*Medical Record Manual .A Guide For developing Countries*". World Health Organization 2006. [Online] Available: https://apps.who.int/iris/handle/10665/208125

[5] InTouch Technologies, Inc., "*The Virtual Care And EHR Marriage*," Teladoc Health. [Online] Available: https://intouchhealth.com/the-virtual-care-ehr-marriage/?gclid=Cj0KCQiAvJXxBRCeARIsAMSkApqTkTKs36zonop1oZt9wNyRWsa4t_5fB2conx2BJUmi-3zZXqbjozgaAsSPEALw_wcB

[6] Elsevier B.V. "*Electronic Patient Record*," Science Direct, Supportive Oncology, 2011. [Online] Available: https://www.sciencedirect.com/topics/medicine-and-dentistry/electronic-patient-record

[7] Roger Collier, "*Electronic medical records: preparing for the inevitable crash*," National Institute of Health, National Center for Biotechnology Information, PMC, U.S. National Library of Medicine, USA, April 15 2014. Doi: 10.1503/cmaj.109-4719. [Online] Available:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3986310/

[8] Healthwise Staff, "Blood Type Test," National Center for Medical Records, March 28, 2019. [Online] Available: https://www.medicalrecords.com/health-a-to-z/blood-type-test-medicaltest

[9] Healthwise Staff, "Blood Transfusion," National Center for Medical Records, March 28, 2019. [Online] Available:https://www.medicalrecords.com/health-a-to-z/blood-transfusion-special

[10] Experity Health, "EMR vs EHR: Understanding Electronic Health and Medical Records," USA, 2019. [Online] Available: https://www.experityhealth.com/resources/emr-vs-ehr-understanding-electronic-health-and-medical-records/

[11] Robert G Sawyer, "Quarantine, Isolation, and Cohorting: From Cholera to Klebsiella," April 2012. DOI: 10.1089/sur.2011.067.[Online] Available: https://www.researchgate.net/publication/223984547_Quarantine_Isolation_and_Cohorting_From_Cholera_to_Klebsiella

[12] U.S. Department of Health & Human Services. "What is the difference between isolation and quarantine? ," HHS.gov, USA, December 2019. [Online] Available: https://www.hhs.gov/answers/public-health-and-safety/what-is-the-difference-between-isolation-and-quarantine/index.html

[13] American Medical Association (AMA), "Ethical Use of Quarantine & Isolation," January 2020. [Online] Available: https://www.ama-assn.org/delivering-care/ethics/ethical-use-quarantine-isolation

[14] Community Service and Environment Development Affairs Sector, "*Medical, Veterinary and Instructive Convoys*," 06

June 06, 2013,Mansoura University, Egypt. [Online] Available: http://env.mans.edu.eg/en/activities-research-en/medical-convoys-en/about-medical-convoys-en

[15] Gunther Eysenbach, "*Workarounds Emerging From Electronic Health Record System Usage: Consequences for Patient Safety, Effectiveness of Care, and Efficiency of Care,*" PMC, National Center for Biotechnology Information, U.S., October 2017. Doi: 10.2196/humanfactors.7978. [Online] Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5649044/

[16] Monica Trujillo, "Clinical Governance Framework," Australian Digital Health Agency Clinical and Consumer Engagement and Clinical Governance Division, October 31, 2017. [Online] Available: https://www.digitalhealth.gov.au/about-the-agency/australian-digital-health-agency-board/board-papers/Item%206%205%20-%20Attachment%20A%20-%20Clinical%20Governance%20Framework_v2%200%20 20180129.pdf

[17] Thomas H. Davenport, Tonya M. Hongsermeier, and Kimberly Alba Mc Cord, "Using AI to Improve Electronic Health Records," Harvard Business Publishing, Innovation, USA, December 13, 2018. [Online] Available:https://hbr.org/2018/12/using-ai-to-improve-electronic-health-records

[18] Samer Ellahham, "Application of Artificial Intelligence in the Health Care Safety Context: Opportunities and Challenges," Middle East Medical Portal, MEMP LTD, 2018. [Online] Available: https://www.middleeastmedicalportal.com/application-of-artificial-intelligence-in-the-health-care-safety-context-opportunities-and-challenges/

[19] Gliklich RE, Dreyer NA, Leavy MB, "*Registries for Evaluating Patient Outcomes: A User's Guide; Managing Patient Identity Across Data Sources*," Agency for Healthcare Research and Quality (US), National Center for Biotechnology Information, USA, April 2014. Bookshelf ID: NBK208618. [Online] Available: https://www.ncbi.nlm.nih.gov/books/NBK208618/

[20] Dusetzina SB, Tyree S, Meyer AM, et al., "*An Overview of Record Linkage Methods*," Agency for Healthcare Research and Quality (US), National Center for Biotechnology Information, Rockville (MD), USA, September 2014. Bookshelf ID: NBK253312. [Online] Available: https://www.ncbi.nlm.nih.gov/books/NBK253312/

[21] Clark, Julius C., Schmider Anneke Elizabeth, Bujoreanu Luda, Marskell Jonathan Daniel, and Aguilar Rivera Ana Milena, "*The Role of Digital Identification for Healthcare: The Emerging Use Cases*," Identification for Development (ID4D), World Bank Group, January 01, 2018. [Online] Available: http://documents.worldbank.org/curated/en/595741519657604541/The-Role-of-Digital-Identification-for-Healthcare-The-Emerging-Use-Cases

[22] Clemens Scott Kruse, Brenna Smith, Hannah Vanderlinden, and Alexandra Nealand, "*Security Techniques for the Electronic Health Records,"* Journal of Medical Systems 41(8), EDUCATION & TRAINING, JMedSyst, Springer, August 2017. DOI 10.1007/s10916-017-0778-4. [Online] Available: https://www.researchgate.net/publication/318636221_Security_Techniques_for_the_Electronic_Health_Records

[23] GeeksforGeeks, "*Computer Network | AAA (Authentication, Authorization and Accounting)."* [Online] Available: https://www.geeksforgeeks.org/computer-network-aaa-authentication-authorization-and-accounting/

[24] Serena Reece, "*What is AAA security? An introduction to authentication, authorization and accounting*," Codebots Blog, Nov 27th, 2018. [Online] Available: https://codebots.com/application-security/aaa-security-an-introduction-to-authentication-authorisation-accounting

[25] Vera Lúcia Raposo, "*Electronic health records: Is it a risk worth taking in healthcare delivery?,*" PMC, National Center for Biotechnology Information, U.S., GMS Health Technol Assess, November 2017. Doi: 10.3205/hta000123. [Online] Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4677576/

[26] UN Legal Identity Agenda, "*Impact of COVID-19*," United Nations, Department of Economic and Social Affairs, Statistics Division, 1June 2020. [Online] Available: https://unstats.un.org/legal-identity-agenda/covid-19

[27] Luana Pascu, "*Argentina enables remote digital ID processing for mobile during COVID-19 crisis*," Biometrics Research Group, Inc., Biometric Update.com, Apr 24, 2020. [Online] Available: https://www.biometricupdate.com/202004/argentina-enables-remote-digital-id-processing-for-mobile-during-covid-19-crisis