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The Challenge and Potential Solutions of Reading Voluminous Electronic Medical Records (EMR): A Case Study from UAE

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Abstract: *The aim of this paper is to shed light on the challenge associated with electronic medical records (EMR) and investigate the most potential solutions to mitigate the problem associated with it. It discusses the issue of reading voluminous EMR's, the causes of this problem and the impact on healthcare provider operations and their services quality; particularly physicians' performance. The current positive and negative contribution of EMR systems will be highlighted and discussed. In addition, a case study from the UAE is demonstrated to investigate the current performance and practices in regard to reading voluminous EMRs within the Abu Dhabi Health Services Company. Furthermore, this paper will discuss the prospective technical and non-technical solutions to the issue. Applying these recommendations will enhance EMR user performance which will positively impact ultimate healthcare provider productivity.*

Keywords: *Electronic medical records, EMR, health care, service quality, voluminous records.*

I. Introduction

In the last decade the healthcare sector witnessed more acceptance and implementation of Electronic Medical Record Systems (EMR). The widespread implementation was due to many factors such as: the high level of maturity of EMR systems in the last ten years, the potential capabilities that IT technologies and systems can provide to healthcare businesses. The EMR systems evolved from just a simple tool to digitalize the hard copy of medical records to be nowadays fully integrated systems with feature-rich platforms. There is a strong demand from healthcare providers for state-of-the-art technologies which improve services, streamline workflows, and manage information.

Healthcare providers use EMR as it is an effective and efficient tool to capture and manage patient-related information from all operations functions. EMR has several advantages such as:

1. Excellent electronic storage mechanisms for the massive amount of medical records
2. Effective communication between health service groups
3. Easy access anywhere, any time
4. User-friendly interactive interface
5. Quickly finding key data
6. Reduction of medical errors
7. Improvement to patient safety
8. Facilitation of cooperation with other service providers
9. Better management for business workflow
10. Integration of different health services
11. Better financial management
12. Support to clinical and business decision-making

However, healthcare service providers underlined several inhibited factors which impact their operation performance. A study by (Boonstra & Broekhuis, 2010) reviewed twenty-two articles which focused on EMR acceptance barriers as per physicians' perspectives. They identify eight categories of EMR barriers with 31 sub-categories. The eight main categories are fiscal issues, technical issues, time consumption related issues, attitude related issues, social issues, legitimate issues, organizational issues and change process efforts. Other studies focus more on specific issues related to physicians' practices with EMR during clinic visits such as: the Interference with doctor-patient association or face to face communication, and the amount of time consumed for data entry and documentation (Kapoor, 2014). In addition, the required time to review large electronic medical records was highlighted by some studies (Meyer, 2010), and other researchers considered the EMR systems usability a major challenge for healthcare service providers (Craig & Farrell, 2010) (Han & Lopp, 2013) (Jain et al., 2012) (Lamberts, 2012).

Physicians, one of the main EMR stakeholders, are the most unsatisfied users with EMR, and their concerns took the highest priority for EMR development leaders. Many interventions were developed to mitigate and overcome these issues, for example the introduction of voice recognition software, digital pens and

the employment of scribes to reduce the consumed time for documentation and data entry (Kapoor, 2014). However, less effort were invested towards the inflation issue of EMR data, to address the root causes and propose practical solutions (Jain et al., 2012).

II. The Problem

With the widespread implementation of EMR systems nowadays, physicians encounter numerous challenges when dealing with EMRs. One of these issues is the reading of a voluminous EMR. The problem intensifies with limited permitted time to be spent per patient and the existing capability limitation of the available EMR systems. In the UAE, the same issue has arised among physicians working for local healthcare providers.

III. Research Methodology

This research is based on qualitative applied research to analyze the research problem and recommend solutions that will contribute in the mitigation of the issues. The research is supported by a case study of the current performance and practices within Abu Dhabi Health Services Company (SEHA) as it relates to reading voluminous EMRs issue. Data was collected using a primary resource and unstructured interviews with the concerned stakeholders. In addition, retrospective data is included from another research study which was reported separately in a paper presented at the 2nd Al-Ain Family Medicine Research Day in 2012 in Al-Ain, UAE.

IV. Background On Electronic Medical Records (EMR)

According to (HealthIT.gov, 2016) Electronic Medical Records (EMRs) are defined as the digital version of the traditional patients' paper charts and records captured by healthcare providers. In contrast to paper records, EMRs enable service providers to document data, monitor patients due time for follow-up and checkup visits and enhance health services quality.

The key players of EMR systems development are: Meditech, Cerner, McKesso, Epic Systems, Siemens Healthcare, InterSystems and CPSI (Modern healthcare, 2016). According to (Gartner, 2015) Magic Quadrant for Enterprise Electronic Health Record Systems (Fig. 1), Epic and Cerner (Millennium) are considered the leaders in this field of technology.

Fig. 1: Magic Quadrant for EHR Systems Vendors (Gartner, 2015)

V. SEHA in Brief

SEHA was established in 2007 by Emirati Decree and is leading in reform of Abu Dhabi's healthcare sectors. In keeping with the government's strategy to identify best global practices and explore competitive ideas, SEHA entered into a number of partnerships with international healthcare institutions. Their world-class capabilities have contributed much to SEHA's growth and development in knowledge transfer, education, promoting healthcare excellence, and achieving goals with competitive advantage.

Today, SEHA's health system consists of 12 hospitals with 2,644 beds, 46 primary healthcare clinics (AHS), 10 disease prevention and screening centers, 3 mobile clinics, 1 school clinic, 2 blood banks, 4 dental

centers, 2 employee healthcare centers, and 1 vaccination center. SEHA is considered one of the largest healthcare networks in the UAE, providing and promoting healthcare excellence, and achieving goals with a competitive advantage. The organization provides a continuum of care to residents by utilizing leading technologies. The organization has more than 17,500 employees spread across the country.

VI. The Challenge of Voluminous Medical Records

EMR content is not limited to a patient's basic demographic information and recent medical procedures. It contains historical medical information about the patient since birth. Such cumulative data over the years will result in a big record per patient and will be bigger if the patient is suffering from a chronic disease like diabetes. Elderly patients' medical records are big with tens of clinical notes, diagnostic reports, radiology reports, vital signs, laboratory results and medications.

It is very challenging for a physician to review a big medical record especially if the patient is new, has just transferred from another clinic, or was using another healthcare provider. Physicians during clinic visits spent more time analyzing a big medical record of a patient to find the information that is really relevant to the patient's current issue (Jain et al., 2012). It is time consuming to go through several hundreds of pages of medical records with a lot of duplication, discrepancies, and variations in the medical assessment of the same patient by different physicians (Meyer, 2010). Other reasons for the inflation of medical records include over-documentation, repetition, cloning, and copy/paste practices by medical staff (Kapoor, 2014). In some cases, the inflation of medical records is unavoidable due to the nature of treatment of certain clinics, such as psychiatric clinics where doctors need to document stories of their patients' life events in order to provide quality treatment for them.

When we discuss the voluminous medical record issue we are discussing in specific two challenges physicians face. First, the 'review' issue of long records to understand the case and check all historical case progression and procedures taken. Second, the 'search' issue within a long record to find specific relevant data related to the present case.

VII. EMR's Contribution To The Challenge

The issue of voluminous medical records was not discovered with EMRs first. It is an old issue that also existed with paper-based medical records. The expectations of healthcare providers from EMRs were high: to overcome this issue and find effective and efficient solutions for it. Unfortunately, this did not appear to be the case. Two studies showed the time allocation by Emergency Department Physicians as illustrated below in fig.2 and 3:

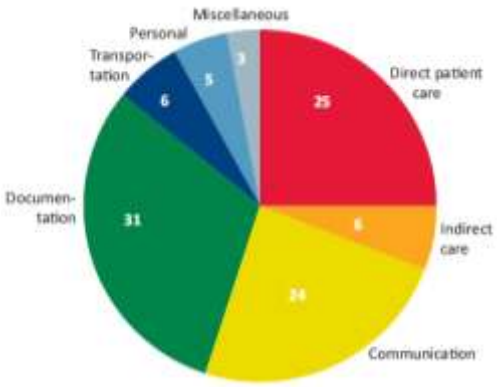


Fig.2: Time distribution by Emergency Department Physicians according to (G et al., 2013)
Fig.3: Time distribution by Emergency Department Physicians according to (Füchtbauer et al., 2013)

These studies showed that the majority of the physicians' time spent was spent on tasks related to EMRs reading and writing, and less time was spent on direct patient care. These two studies have two limitations: first, they focus on the Emergency department only where the need for a historical record is not needed all the time, and second, they focus more on the data entry issue than data review and search issues. The situation will be worse in other healthcare departments, like primary care or outpatient clinics, where physicians need to review a lot of historical data.

From a neutral point of view, EMR systems have made significant improvements aimed at solving the problem of voluminous medical records through embracing IT to manage massive amounts of data where it can be retrieved and represented in a practical way to meet user demands. However, gaps between service design (SD), customer experience (CX), and user experience (UX) are still observed with many existing EMR systems. These gaps are obvious in early stages of implementation of EMR systems.

The EMR systems maturity level and customer acceptance level will be improved year by year with the widespread adoption of EMR systems and cooperation between system vendors and healthcare providers. There is still room for more improvement. Some potential improvement options will be discussed next.

VIII. Potential Improvement Solutions

As mentioned previously, there are two major challenges when dealing with large medical records: the need to 'review' the whole record, and the need to 'search' for specific data within a big record. Both of these challenges impact physician productivity, responsiveness, and the quality of healthcare services. Both IT solutions and human-based solutions can contribute positively to 'review' and 'search' challenges and reduce the negative impact. This section highlights two potential improvement methods: First, IT-based techniques which include interface improvement, data representation improvement, and intelligent search tools, and second, human-based practices which include personal skills improvement, knowledge sharing, and delegation.

1. IT-based Techniques

1.1 Interface Improvement

System interface design and capabilities are key success factors for any electronic medical record system. The interface either enables users to gain the most from a system or constrains them and limits their ability to smoothly interact with the system. The numerous advantages of EMRs can be forgotten when users are constrained with inferior system interface (Craig & Farrell, 2010).

Existing EMR systems widely use GUI (Graphical User Interface) to allow users to interact with the system. Most of these interfaces are outdated with regard to design and usability. They have fixed and rigid structured sections that oblige users to follow predefined workflow procedures. Physicians today require a more user-friendly system interface with more options to help improve their productivity.

The new system interface should move from a standard GUI to a more adaptive user interface (AUI), where interface layout and elements can be changed according to user needs. The new interface should take the style of a system portal where users can access many subsystems from one page. System Portals are designed with usability and flexibility capabilities and customization options. Such a portal interface allows users to change, adjust, add and delete components based on their needs and unique style. In (fig. 4) an example of a traditional GUI is shown and in (fig. 5) an example of the recommended future portal concept is presented. The recommended system portal should be very interactive with real-time information, communications, and alerts.

Newer versions of some EMR systems introduced the use of Widgets with their interface design, which allows users to personalize their screen to show information that is relevant to them, and provides consolidated data from the EMR system in one screen (Meditech, 2016). The recommended future portal will allow physicians to have better control of the needed functions of the EMR system. It will facilitate their preferences of reviewing patients' medical records, help them highlight the relevant information from the big record, and ease the search and navigation competency for specific data.

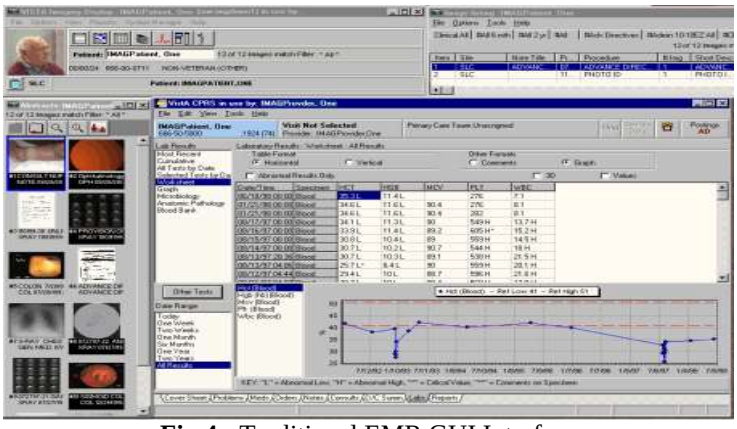


Fig.4: Traditional EMR GUI Interface

Fig.5: Recommended Future Portal Concept (Microsoft, 2016)

1.2 Data Representation Improvement

The second area for improvement in most current EMR systems is how they represent the retrieved data. Most of current systems use the same form of data entry and order entry templates to represent patient records. Some systems utilize visualization and charts to display EMR data. However, they are actually using still images for visualization and static charts showing a small amount of data out of much more relevant data.

EMRs vendors need to take a transformation effort to facilitate users' expectations from EMR systems. Users are looking for more than just computerizing the existing paper-based medical records; they are looking for more intelligent and innovative technological tools to overcome old and painful challenges with medical records.

The two main issues of voluminous medical records (Review & Search) can be mitigated if vendors utilize some advanced techniques for data representation such as interactive visualization, dynamic charts, smart tables, dashboards, time line view, and data-driven storytelling. Such techniques can translate unstructured data to be summarized in an easy to read and navigate display model. These models can allow users to expand and dig to more details if needed through hyperlinks and pop up boxes or description boxes on mouse-over. Users will be able to review big reports faster than traditional text based and simple chart methods.

Many physicians prefer to have a simple easily accessible summary for each visit note and the choice to read more if he/she needs to do so (Lamberts, 2012). Abstraction of big medical reports or notes should be done through intelligent system capabilities to give an effective summary. Nowadays, Natural Language Processing (NLP) techniques are used to summarize data from text fields within EMR (Lin et al., 2013).

Moreover, data representation should be customized based on different clinics requirement and to avoid one model for all. Customization or function-based data representation tasks need involvement of users to understand their business and make the best fitting model that will improve their ability to review big records.

1.3 Intelligent Search Tools

The ability to quickly search and find pertinent information is invaluable, evident in the fact that more than 50 percent of Internet users begin with a search. Within healthcare, where clinicians collect patient information over a lifetime, the ability to search is imperative. While many electronic medical record (EMR) systems offer physicians some search capabilities, current functionality is extremely limited.

Physicians are spending a huge amount of time searching for data within a voluminous medical record (Lamberts, 2012). They are looking for a system with an easily searchable content and a powerful full-text searching tools which allows searching structured, unstructured and text free records including the searchable images and scanned documents. Such system capability will reduce the consumed time per patient which means better productivity, satisfied customers and high quality services.

Most of the existing EMR systems provide basic searching tools within the medical record which are limited to word matching searching capability. With such basic searching tools physicians end up with a long list of irrelevant data to be scanned again to find the desired information.

EMR systems vendors need to utilize more advanced searching technologies which are able to emulate human behavior by understanding the intent behind the search question based on context then provide the most relevant answer. These search techniques called Semantic Search aim to improve search accuracy by enabling search engines to recognize the intent of the user and the term's contextual meaning within the searchable records.

Semantic search techniques aim to provide the most relevant results by retrieving knowledge from voluminous structured data records. Such technologies have the capability to handle several matching options to deliver the most accurate result, some of which are concept matching, knowledge matching and natural language

queries and questions. For EMR systems, vendors need to develop their own Semantic Search system which will apply data analysis and indexing for general healthcare terms and expressions and customized analysis for the benefiting healthcare provider.

Some of today's leaders in EMR business announced that they start adopting semantic search techniques such as Chart Search solution from Cerner (Cerner Corporation, 2012). IT leaders also recognized the huge demand for semantic search technologies from the healthcare sector and developed solutions to meet this demand. For example, IBM developed its own Medical Record Text Analytics solution (IBM Corporation, 2010).

2. Human-based Practices

In addition to the technical or IT-based techniques there are several non IT-based options to improve user experience with EMR systems and reduce the huge spent time to go through a voluminous record or searching for explicit data within the EMR data-space. These options focus more on user competencies rather than system capabilities.

2.1 Personal Skills Improvement

Electronic medical records (EMRs) are different from traditional paper charts as they require new computer skills to read and navigate electronic documents. Physicians' computer reading and navigation competencies play a significant role in how they interact with EMR systems. According to (Han & Lopp, 2013) maximizing physicians' navigation skills can improve precise EMR writing and reading.

To improve the process of reading a voluminous EMR, healthcare providers need to recognize the impact of weakness in computer skills among their medical staff in particular the elder generations, and work on improving their skills through system training; and skimming, scanning and searching reading techniques exercises.

2.2 Knowledge Sharing

Healthcare providers need to encourage knowledge sharing of best practices and lessons learned between EMR system users. Users of EMR systems, like any new system users, developed their own best practices on how to navigate through the system and get the best out of it based on their unique needs. The development of personal best practices is intangible knowledge which requires more effort to be transferred from person to person.

The second diminution of knowledge sharing is the collaboration between system users and system vendors to share system related concerns and build common ground for user expectations and system capabilities. Both healthcare providers and EMR systems vendors need to encourage this collaboration for their mutual benefit.

Knowledge sharing could take place in formal and systematic approaches like formal meetings, discussion sessions, forums and knowledge management implementation, and it could take place informally through person to person discussion and coffee break chatting. Both ways of knowledge sharing need to be facilitated by healthcare providers and integrated into their organizational culture.

2.3 Delegation

When physicians find themselves overwhelmed with many tasks related to EMR (data entry, reading and searching), they may delegate these tasks to an EMR System Assistant who can do the necessary EMR tasks on their behalf.

This is not a new concept with regard to data entry. The utilization of Scribes is widely adopted by many healthcare providers. However, it may be a new concept with regard to EMR reading, navigation and searching. Employment of Scribes in some medical departments has proven to be a cost effective option and successful enhancement for both physicians' and patients' satisfaction (Kapoor, 2014). Applying a similar concept to have an EMR Narrator or EMR Searcher will be beneficial for many service providers to facilitate voluminous EMR reading and searching issues, increase physicians' efficiency, and improve stakeholder satisfaction. Healthcare providers may combine the two functions, the Scribes and Narrator, to be carried by the same person who can be referred to as EMR System Assistant..

IX. Case Study: Challenge of Reading Voluminous EMRs In SEHA

The UAE has implemented the EMR system (Cerner) since 2008 in Abu Dhabi and Al Ain. Since information and research studies related to voluminous medical records and physician satisfaction in EMR usage is lacking in the local context, the retrospective research is limited and further research studies are recommended. In this case study we would like to counter the main challenges in reading big data in a patient's file and the most effective potential solutions which were implemented in SEHA.

As mentioned earlier the two main challenges that physicians encounter when dealing with big volumes of data in patient files are data reviewing especially patients with chronic disease which causes the physician to spent most of their time searching for specific recent data, thereby hindering the physicians from providing high quality care due to poor design of electronic health record systems. This issue led to increase patient waiting time, and this is the main problem which SEHA faces now. Nowadays, waiting time has become one of the KPI's in SEHA. The difference between operational management goals and physicians' goals make the issue more challenging as one physician stated that "the operational management limits us to see a patient in 20 minutes as this the SEHA KPI target aimed at minimizing patient waiting time. I will not be able to review patient medical records properly before diagnosing and treating my patients". Many other direct and indirect factors contribute to this issue like human-based factors which include level of readiness for change from paper work-based systems to a computerized charting system. In addition to that, personal skills which were observed with many physicians in SEHA health facilities especially older staff are another factor. Communicating system changes to these physicians is always a challenge. Some doctors are too busy to read emails and memos, and end up being surprised by system changes or upgrades.

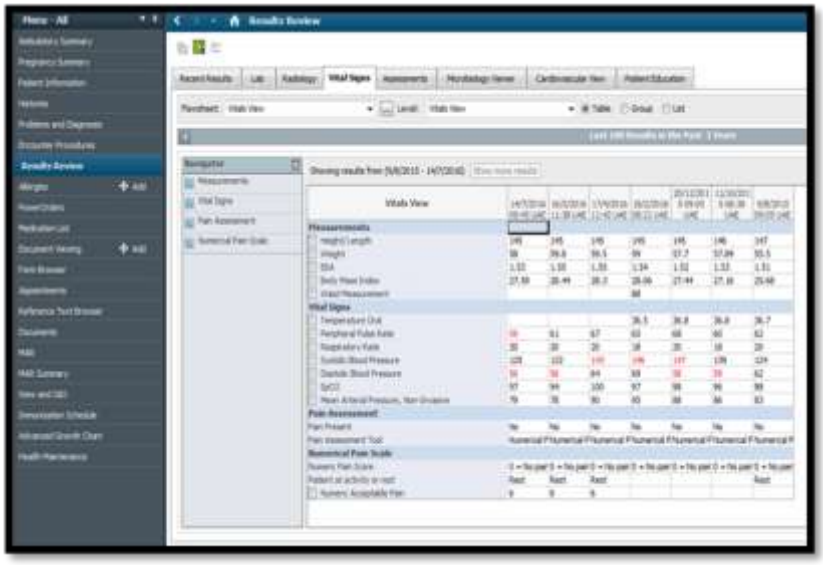
One of the major factors that contributed to this issue is that many physicians are not familiar or fully aware of the benefit in reviewing medical records and many physicians practice their own school practice. This is due to insufficient training provided by the primary organization. On the other hand, it is very important to mention that the patient also has a strong impact on this issue since patients are always in a hurry to see the physician and overlook the importance of the physician reviewing medical records prior to attending to the patient.

With regard to challenges which are system related factors, first, un-unified computerized charting systems among SEHA facilities lead to missing or duplicating data entry which has a negative impact on the review of medical records. Second, difficulty in accessing the patient's medical records due to insufficient or shortage of numbers of computers at the earlier stage of implementing EMR. Third, the continuous system changes which have their pros and cons.

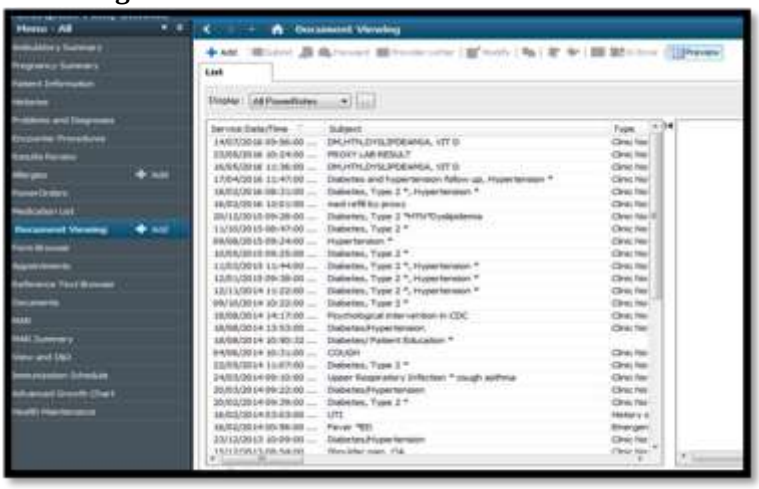
Searching medical records data, is the other challenge which physicians in SEHA face. Unfamiliarity with the system, continuous changes, inadequate training, and unstandardized documentation are all factors that lead to difficulty in accessing data and improper searching practice in patient medical records. The key surface barrier to electronic medical searching is the absence or unavailability of a clear tool to be used while searching for medical records data. Most of the data in patient reports is text-free, so the variety in documentation and content leads to un-unified search practice among physicians.

Fig. 6 shows some recent snapshots from the existing SEHA EMR system (Cerner) showing the available intelligent tool interface, a medical records reviewing data example, and a shared reports example.

Intelligent Tool



Medical Records Reviewing Data



Shared Reports

Fig. 6: Snapshots from the existing SEHA EMR system (Cerner)- Source: SEHA

In regard to the two main challenges in dealing with big data in patient medical records: SEHA recognized that these challenges have negative impact on patients' quality of health care and physicians' satisfaction and productivity. Operational management collaborated with other entities to tackle these issues in various ways and managing them with proper solutions. The following are some interventions which had a positive impact on patients and physicians satisfaction and enhanced the quality of healthcare:

A. Enhance physician engagement with the system by providing continuous updates and training, empowering them with full knowledge about the system. This is linked with the employee orientation program.
B. Provide effective practical training about system usage that is monitored by a trainer in conducting a competency checklist annually. This helps physicians become better users of the system and increases their efficiency.
C. Provide training related to computer usage skills
D. Link system-use skills to individual competency performance
E. Provide laptops, and a Cow (a mobile computer) to speed up physician contact care to patients
F. Operational management in collaboration with Business Intelligence and analytic department (IT) in unifying EMR practices among all SEHA facilities (pre-completed test documentation, order set, standardized abbreviation, new guidelines developed, voice recognition tool, dashboards and dynamic charts)
G. Minimizing free text (unstructured) data
H. Develop intelligent tools, for example to searching lab results or radiology results with one click.
I. Assess physicians' practices and share learnings and best practices among facilities

X. Conclusion

The challenge of reading a voluminous electronic medical record will continue to exist as long as patients' medical data volumes continue growing. Maximizing the use of structured data (templates, drop-down menus and check boxes) for data entry will organize data represented and reduce the consumed time for reading and searching. However, this is not the case all the time; the use of unstructured data entry (free text fields) is unavoidable.

Healthcare providers need to enforce good practices for data entry and documentation which will ease the navigation process later, some of which include the elimination of scanned records or fax images by scripting or digitizing them using image-to-text tools (Optical Character Recognition). The most effective proactive movement is that both EMR systems vendors and users need to apply some practical solutions to mitigate the challenge of reading voluminous EMRs and reduce its negative impact on healthcare services. This paper highlighted six potential solutions classified under two categories: IT-based techniques and human-based practices.

Some of the proposed solutions have already been introduced by EMR vendors and there is a need to evaluate their effectiveness and impact on improving users' ability to perform better with voluminous EMRs reading and searching. This will be a good subject for future study and field research among major adopters.

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