

Evolution, Prospects, and Challenges in Hospital Management Information System: Case Studies

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Abstract— Nowadays, a Hospital Management Information System (HMIS) is one of the requirements for every private or public hospital. An HMIS is desired for several reasons such as efficient operations management of the hospital, time optimization, reducing the paperwork produced in the process, etc. The HMIS also helps maintain patient and hospital records for a long period of time. Most importantly the HMIS ensures quality assurance and patient satisfaction by delivering at very high standards. Finally, the data collected and generated through the HMIS is based on collective information from various departments and components of the hospital and can enable a person to analyze this data and make intelligent decisions for the betterment of the hospital, its staff, and the patients. The data generated can be visualized to seek insightful information, and these insights can be plotted or researched further to make relevant conclusions and help the medical world to make innovations and advancements in the field. This study aims to enlighten the reader on the various communities in a hospital setting. It also presents case studies mapping the progress made by the HMIS over the years. Moreover, it also presents the prospects and challenges in the domain.

Keywords— Artificial Intelligence; Hospital Management Information System (HMIS); Electronic Health Records; Patient Records.

I. INTRODUCTION

In referring to the past archives, a lot of those archives suggest that developed countries like the United States first introduced the Hospital Management Information System (HMIS) in the early 1960s and since then the HMIS has evolved over the years. In the year 1965, at the Los Angeles County General Hospital, an identification file that included patient name, birthplace, etc. for 1,00,000 patients was created using a punched card system. In the 1970s object-oriented databases started being used. By the 1980's the volume and complexity of patient data, and health records increased substantially. The time between 1970-1990 was the one that shaped the major evolution of the HMIS. In the late 1980s new technologies like the Health Level 7 (HL7) played a detrimental role in advancing the then HMIS system and Technology [1]. Post the 1990s the HMIS started being adopted by more and more countries, in the hospital setting. As the world entered the 21st century, the number of services and the complexity of tasks that the HMIS could provide, and the handle had increased drastically. With fast advancements in the field of information technology, slowly and steadily in the first decade of the 21st century, the HMIS

also witnessed substantial growth and development. From the beginning of the second decade to the present date, the HMIS has become one of the most essential components of a hospital. There are several leading as well as small-scale service providers who provide HMIS services [2]

II. OVERVIEW OF HMIS

Managing the Hospital operation is one of the most critical tasks and nowadays it is taken care of by a hospital management information system or a hospital information system. It is a series of software systems that are used to govern important tasks like collecting and managing information, managing billing and hospital schedule, maintaining Electronic Health Records (EHR) [3], etc, and most importantly keeping all things digital and organized. To add more, an HMIS also links various units of the hospital internally, for instance linking doctors to the pharmacy and laboratories [4,5]. For the time before the use of an HMIS, all these tasks of managing and maintaining information were performed manually and there was tremendous paperwork that was done. This paperwork was vulnerable in several ways, not only for the hospital but also for the patient, and most importantly above all inefficient use of the data that was being generated. With the HMIS in place, hospitals are operating seamlessly, and patient satisfaction has also been impacted positively. The factors like patient safety, trustworthiness, etc have also been incorporated. In a certain way, an HMIS can be termed as a product that is used by hospitals or a product available in the medical world.

III. COMPONENTS OF HMIS

As seen in figure 1, the various components managed by an HMIS in the hospital setting include Laboratories, nursing and wards, consultancy, patient admission/registration, blood banks, stores, pharmacy, and others like the operation theatre and the radiology unit. All these important services are linked to each other via the HMIS and collective information gathering, and processing happens in the system. An HMIS links all these factors in a hospital, along with interlinking these parameters with the hospital structure. The interlinking of the health professional, the radiology community, the pharmaceutical community, the patient care community, and the administrative community with the services in the hospital. Hence HIMS integrates all the collaborators and service providers on a single platform. All these components perform major functions in the

hospital. For instance, ward management allows the administration to keep track of the rooms occupied, the number of patients in the hospital, etc. The blood bank data allows hospitals, especially in situations of emergency to coordinate and fulfill the blood requirement. Overall, the HMIS affirmatively guarantees the smooth functioning of the components and proper management of the data.

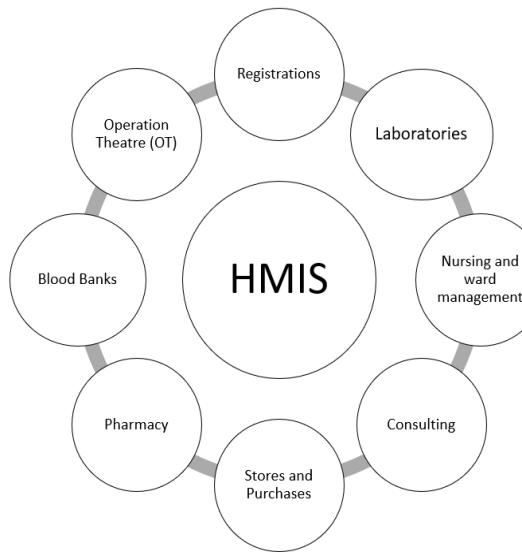


Fig. 1. Components of HMIS

IV. COMMUNITIES AND SERVICES IN HMIS

From figure 2, the various communities in the hospital include the admin community, the patient care community, and the clinical community comprising doctors, specialists, and nurses. The figure shows task management in a hospital, and how the HMIS system links the various communities like the clinical and radiology community to essential components of the hospital like pharmacy, nursing, wards, etc. The HMIS system brings synchronization between various departments in the hospital. For instance, the admin community which through the HMIS will handle billing and patient services will be connected to other departments like consulting, patient admission, etc. which will allow for fast and smooth execution of processes and will also lead to patient satisfaction. The overall coordination and workflow management of inter-department and intra-department will happen seamlessly. As observed from the figure the various services that the HMIS provides include patient services like scheduling appointments, patient registration, etc. Other services include clinical services like a record of clinical units like the radiology unit, the pathology labs, etc. The HMIS also provides administration services like billing, staff management, and maintaining medical records and archives, and miscellaneous services like managing biomedical waste, and providing information about the hospital through information centers and kiosks. The HMIS also provides useful and essential services like patient education. The outcome of the process through the working of the HMIS system results in in-patient and out-patient management, medical issue management, and managing lab reports and patient health records. The other key outcomes include managing the information in the hospital, waste

management, inventory and dashboard management, and others alike. Overall, the service provided in a particular HMIS product varies as per the requirements. For instance, sometimes the institutes and hospitals who deploy the HMIS only deploy it for administrative services like billing and managing patient records. Some other organization can make use of even more complex HMIS products which provides services right from administration to patient care also covering LABS and the clinical community, so basically, it all depends on the requirement and the type of services deployed and availed.

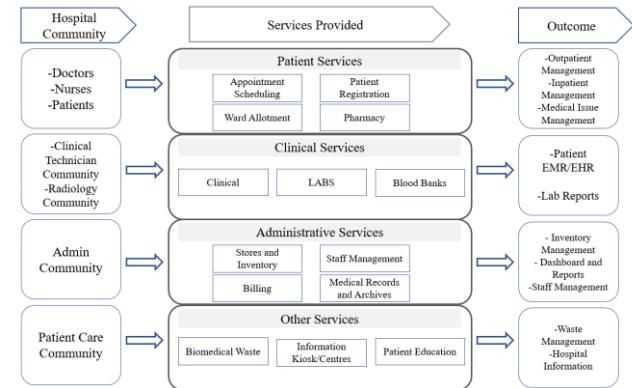


Fig. 2. Communities and Services in HMIS

V. EVOLUTION OF HMIS

Fig. 3. shows the subsequent rise in the field of HMIS, a software designed to collect, store, and analyze patient records, equipment data, management, and decision-making in hospitals. In the early stages of HMIS, the system was used simply to store, collect, and analyze data but the paperwork was also a part of the administration functionality in hospitals. HMIS was not as largely used and appreciated as it did in the coming years. Several hospitals started integrating their systems with HMIS around 2012, and most of the hospitals had made several advancements to make the software efficient and sustainable. The growth of HMIS till 2022 increased at a fast rate with time as the majority of the hospitals had adapted to the system-managing software due to its date quality assurance and rapid maturation of the system. The Histogram depicts the timely rise of the use of HMIS in various health facilities and organizations and the improvement of the quality of the software with an increase in its demand.

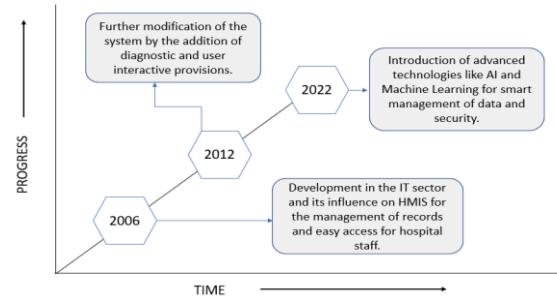


Fig. 3. Progress in HMIS

Case 1: The National Taiwan University Hospital (NTUH) has been implementing a Hospital Information System (HIS) since the 1980s and has been efficiently processing along with developments in medical technology

with Healthcare Enterprise Information Portal (HEIP) as the essential base. However, the hospital was facing major backlash financially due to the expense of the annual maintenance of the HIS system. To overcome such circumstances, significant steps were taken to make changes and modifications to the HIS system. HEIP was developed to improve the quality of Customer Relation Management (CRM) by making it an integrated and user-friendly software. To further implement quality HIS, NTUH established online services for the management of vaccination records and emergency services around the country by making it a web-based and unified system. The proposal for online emergency services was made by keeping in mind the factors such as immediate response and action, providing first-aid instructions that are time-based, and enhancement of communication quality. SIP, JMF, RTP, and JDBC are the technologies that were implemented for the prototype. [6]

Case 2: This case study refers to the reformation secured in the Electronic Health Record (EHR) of a hospital in Nigeria. The existing system at the Babcock University Teaching Hospital (BUTH) in Nigeria provided a monotonous and time-consuming method of acquiring a patient's medical record. It involved going through a profuse amount of paperwork and administration registers for the procurement of details. The overall method proposed for a transformation in the patient record management system was given the name of 'Waterfall Method', which involved the development of a linear, systematic, and hassle-free method of collecting and storing patient records, and it was also made open to the public opinion for modifications in software and hardware of the system. It not only provided a standardized patient record method but also had a division for diagnosis, using a user interface and it was highly interactive since it involved disease diagnosis using the symptoms shared by the patient online. The main aim of the method proposed was to recover as well as maintain information effectively by the immediate enlistment of updated details and by the information captured from the section where the tests and diagnosis take place. The model was seen to be a huge success as it was sustainable and well-maintained with regular service maintenance. [7]

Case 3: Taking into consideration the COVID-19 situation in 2022, technical support was provided by Information Technology and Artificial Intelligence in the Children's Hospital of Fudan University (CHFU) for non-contact monitoring and management. These included the use of Internet Hospitals, Face-Recognition Technology in outpatient systems, and a structured Electronic Medical Record system in the inpatient system. The entry and exit terminals of the hospital were set up with Face Recognition and Risk Identification technology. The staff members of the hospital could easily log in their entry through automated confirmation software and their entry and exit time would be transferred to the Central Software of the hospital. This technology set up a semi-permeable entry and exit system which further rationalized the security system of the hospital. [8]

The patient-oriented benefit of this technology is the method of ward and bed assignment of each patient, based

on the criticality of their health. The patients with negative RTPCR tests were provided with yellow or green QR codes and the ones with positive RTPCR or positive Nucleic acid tests were provided with red QR codes. The colors of the QR codes have corresponded to the various risk factors of the patients. Using Structured Electronic Medical Records, the formation of records of inpatient and outpatient numbers of COVID-19 victims was automated. The hospital managers were provided with a multi-channel display of dynamic data on COVID-19 patients which could be examined and altered at any time using mobile phones and computer terminals. The display consisted of the number of patients hospitalized on that day, the average length or number of hours of hospitalization of a patient, the number of patients discharged and admitted on the same day, and the number of cases monitored and treated at the same time. Along with the numeral record, it also displayed the graphical record of the same parameters based on the volume of inpatient and outpatient statistics. [8]

VI. CHALLENGES AND THEIR SUCCEEDING SOLUTIONS DURING THE EVOLUTION OF HMIS

In Case 1, the major backlash faced by the NTUH was the dependency of the NTUH HIS on Microsoft technologies. The problem was detected to be the way the Web Service Container was implemented for the development of HIS which resulted in difficulty in decoupling and communication between distributed services. To overcome the situation, the hospital decided to deploy an aggregation of identical servers with the help of Layer 4 Switches. It ensured running the system with minimum backlash in communication and improved the availability and concurrency of the system. Firewalls were also installed for the security purpose of the design. [6]

In Case 2, the expert system created by BUTH turned out to be the most useful and undoubtedly the most successful feature of the entire system proposed. However, the diagnosis section seems to stay limited. The design of the software only allows it to diagnose four diseases- Cholera, Malaria, Tuberculosis, and Hepatitis and the system also does not carry out any examinations, only tests, and limited diagnosis. A feasible solution to this was kept in mind and the system was made flexible and capable of accommodating new requirements to make it capable of further extension in the future by specialists. [7]

In Case 3, the author of the paper [3] states the predominant reason behind acquiring the support of Information Technology (IT) and Artificial Intelligence (AI) for management experiences. The high reputation and grading of the hospital put a lot of pressure on the proper treatment of other children as well as the children who tested positive for covid, together. It had to ensure strict prevention of the occurrence of nosocomial diseases which compelled CHFU to introduce AI and IT for management purposes. The most evident success of their methodology was the execution of Internet Hospitals. It prevented the further occurrence of nosocomial diseases at a large scale while still being efficient and sustainable despite it being online. However, the scope of such enhanced and advanced

technologies remains unappreciated since this automation has only been implemented in CHFU and no other hospitals, which coerced limitations. [8]

VII. FUTURE PROSPECTS IN HMIS

Hospitals integrated with HMIS, and other departments yield a huge amount of patient data and medical history records. [9] This data must be brought to bear the responsibility of generating deep data, including the inflow and outflow of patients, the number of admissions and discharges per day, the record of patient medical history, inventory, and data access and security. Introducing AI in departments such as administration, finance, and security terminals can reduce the number of manual operations, and errors and improve the quality of customer relations in the hospital as it benefits the patients at the maximum level. [10]

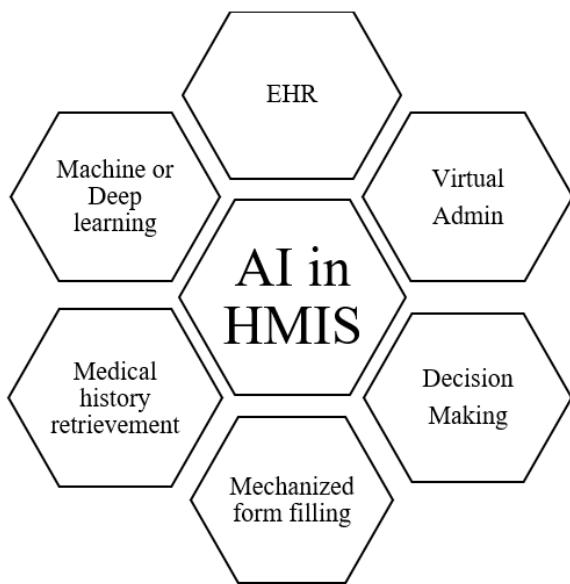


Fig. 4. Fields developed by integration of AI in HMIS

Figure 4 shows the components applicable for the upgradation of HMIS using AI. Electronic Health Records (EHR) correspond to the paperwork of a hospitalized patient. With the help of AI, this system can be digitalized and automated for better access and to reduce additional inconveniences to patients. Certain important factors of a hospital's information management such as Virtual admin and Mechanized form-filling are the automated versions of the hospital administration department which provides the patients with an advanced help desk facility consisting of computerized reception assistants and form-filling procedures integrated with modernized technologies. Medical History Retrieval refers to the restoration and extraction of data that is several years old and is difficult to maintain as paperwork. It can be considered as a part of EHR; however, it can be branched out individually since the implementation of AI required by it has unique algorithms. Machine Learning or Deep Learning has a wide range of potential for growth in the healthcare field based on speech recognition, data analysis, computer vision, and decision and prediction-making using data that has been collected.

The overall intention of using AI for Hospital Information Management is patient-oriented and for the

benefit of healthcare providers. The increased use of AI will benefit paperless records, improved inventory, and better security of hospital staff as well as of the patient medical history information as shown by the result of a survey taken in the paper [10]. In the paper [10], 12 physicians were asked to examine the records of two types, one with AI optimization and one without. The results suggested that the records implemented with AI optimization do turn out to be time-saving and more convenient than the traditional methods.

The implementation of AI can be in various aspects such as at the Reception Desk of the hospitals for bill payment and form filling. The rather inconvenient necessity of form filling before the patient can be hospitalized could also be solved by using Face-recognition technology which can collect the data from the city's Big Data center [8,14] and automate the process of form filling as soon as the patient enters the terminals of the hospital. Speech recognition technology, including translator software for the language barrier, could be implemented for the help desk sector of the hospital for the provision of medicine availability, Mediclaim conditions, and bill payment process. [12]

This could result in a major success rate of hospital treatment quality, however, could also result in the unemployment of staff which will eventually, distress the hospital staff along with the city's employment rate. These methodologies do seem effective and revolutionary but involve just as large an amount of investment and risk factors, especially for developing countries. This limits the expansion of such technologies in several hospitals due to restricted funding and negligence in the acceptance of new methods because of psychological barriers.

VIII. CHALLENGES

Healthcare Organisations need to mandate the security of data collected by enhancing privacy and security. However, in today's world where cyber security violations are so often in existence, it is difficult to make a security system strong enough to defend from bypass activities. [13] This makes it difficult to build trust among the government, patients, and leading healthcare organizations.

The greatest challenge in AI is the acceptance of technology by patients, staff, and healthcare organizations conducting daily clinical practices. [10,11] AI must be approved by regulators, considered by medical experts for diagnosis and data recollection, trusted to be integrated with EHRs of the hospitals, and funded by payer organizations for updates and modifications. These factors make it limited concerning the use of AI on a larger scale. [15]

IX. CONCLUSION

This study involves a systematic and holistic review of the origin, components, implementation, and evolution of HMIS with time. The study also presents various case studies to demonstrate the evolution and progress of HMIS over time. The influence of IT and AI on HMIS can be proved to be revolutionary for patient and hospital staff satisfaction as well as in the quality of the services provided by health facilities and organizations. The challenges faced

in the integration of AI in HMIS along with the challenges faced in the development of HMIS have also been discussed.

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