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OPTIMIZING USABILITY OF ELECTRONIC HEALTH RECORD

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Abstract
Health sector of Pakistan is deprived and under privileged. Basic reasons are illiteracy, difficult procedures, high cost, unsafe care and less access to medical services which decreases user satisfaction and cause medical errors. Integration of electronic health records in health sector can improve health care. The research aims to enhance usability, user satisfaction, effectiveness and efficiency by creating a user centred design of electronic health record. Literature review gives an understanding of problem, issues decreasing user satisfaction, efficiency and usability of system. User study has been done from doctors, patients and medical staff from hospitals of Gujrat and Islamabad. On the basis of results an interface of electronic health record has been proposed with improved usability, better user satisfaction and greater effectiveness. The results show that EHR must be dynamic and adaptive to increase usability of health system with better user satisfaction, efficiency and effectiveness.

1. INTRODUCTION

World Health Organization defines Health care as efficient, effective, patient centred and safe delivery of medical services. Unsafe care is a major contributor to poor patient outcomes especially in countries with low income and high illiteracy [9].

Physicians and medical staff have to cope with many challenges like environmental pressures, demographic changes, increased aging and introduction of new technologies. Patient centred care is the responsibility of physicians, medical staff and patients inside or outside the hospitals [29].

Patient satisfaction is the degree to which provided care meets individual's needs and expectations. It is achieved by combination of patient feedback, efficiency of services and better patient-physician relationship. [29].

Medical errors like diagnostic mistakes, medication errors, less accessibility, errors in prescriptions are leading cause of deaths across the world. In USA between 50,000 to 100,000 people die in hospitals every year and 1000,000 injuries are the result of medical errors, 23% Europeans, 185, 000 Canadians and almost 11% of total deaths in Australia are caused by medical errors [29].

It is necessary for patients to understand and manage their health. This is usually achieved by health information systems and health websites. These applications provide safe and efficient care at reduced cost and time [11].

Technological advancements are gaining popularity to increase patient safety, quality of treatment at reduced cost of treatment. Many ICT applications have been adopted to serve needs of health professionals like electronic health records and computerized data entry system [22].

Timely access to clinical data independent of location and type of treatment cause a vital difference on health care. Such factors encourage adoption of electronic health records by better management, effective care and quick information retrieval with increased transparency [10].

International standard organization (ISO) define Electronic health record as "repository of

information regarding the health status of a subject of care in computer process able form" [23]. It can be referred to as computerized patient record, electronic medical record, digital medical record, automated medical record and patient medical history [23].

The term electronic health record (EHR) refer to patient record across multiple areas of health. In this paper, the term EHR refer to longitudinal, integrated system designed to collect patient information from multiple sources of care. Poor usability lowers clinical and decision support system effectiveness and compromises patient health efficiency [43].

Despite effective role of EHR, adoption is less till to date i.e., just 10.1 % worldwide [26]. EHR were originally developed to standardize quality of care, decrease cost and reduce medical errors to zero. But yet they have to deliver what they were originally designed for [20]. EHR streamlines clinical workflow, help in decision support and improves clinical efficiency. But it has less usability and low potential [43].

Usability is a major factor in effectiveness and efficiency of electronic health records. It enables health personals to ensure that system is usable for patients, physicians, and clinical staff [29]. Although critical for successful adoption but usability has not achieved importance like other features such as software and technical needs [36]. This research paper focuses on usability of health records, user satisfaction and issues effecting usability and user satisfaction by pre and post study. In Pre study data has been collected from patients and physicians from Gujrat. Electronic health record used at SHIFA international hospital Islamabad has been taken as model and satisfaction of Physician and medical staff with EHR have been measured. Collected data is analysed by SPSS 0.21. Based on results an interface of electronic health record is proposed in which features to improve usability and user satisfaction have been added. In post study proposed system is tested with doctors and patients of Gujrat.

1.1 Usability Evaluation Protocol proposed by NIST

The evaluation protocol proposed by NIST is the model for determining usability of EHR. It defines three steps for validating EHR usability. These steps are performed to identify critical issues which should be evaluated [10].

Step i: Application analysis

Application analysis is done to identify main functions of EHR like basic use, user characteristics, interaction between users and EHR to identify critical issues for patient safety.

Step ii: Expert review of user interface

The review is conducted by usability experts or developer's team. The evaluator compares user interface against specified standards. Design issues that may lead to problems are identified. The review team can modify design to eliminate problems that creates issues.

Step iii: Validation test of user interface

User performance related to critical tasks is evaluated. The performance is evaluated by post-test user study. The goal of test is to ensure system doesn't lead to patient safety incidents.

2. Literature review

Health care is a costly enterprise. In US health care costs are $2.2 trillion per year, UK spends $ 2,317 per person per year [36]. According to WHO annual spending on health care increased to almost 30% across most of South Asia. Malaysian expenditure on health care increased to 43.6% from Indonesia to 67.8%, Singapore to 42.4% and Brunei to 22.6% in 2020 [35].

Pakistan's population is approximately 153 million i.e. world's sixth largest. About two third of population lives in rural areas with scarcity of facilities, infectious diseases, errors, diagnostic mistakes and poor coordination in distant areas [18].

Third world countries have less access to medical facilities. There is a need to design system based on process mining and formal verification to enhance interaction and sharing of data in medical spectrum. This can help in reduction of

health problems and improve quality of health facilities [45].

People with low literacy and poor reading skills experience difficulty in accessing and understanding medical expressions which puts lives of people at risk [20]. Integrating information technology can reduce errors, enhance patient-physician communication and improve user satisfaction [22].

Patients require access to accurate and evidence-based information. There are many sources about health information i.e., internet, books, conferences but there is a need to direct patients to safe and accurate sources [44].

Recording patient information on papers causes errors. Miller et al in 2005 identified paper-based records as ambiguous, poorly accessible and incomplete [12].

Learum in 2003 identified recording patient information on paper effects continuity and quality of care. The issues of temporal and money decrease information usability and accessibility. Paper-based records have less accessibility and low durability [12].

Information technology applications can be diffused with clinicians and patients by electronically connecting hospitals, training professionals and sharing medical record for follow up [14]. The applications can be helpful for improving usability of health applications by minimizing errors, better communication, less cost and increased availability of decision support data [36].

Currie and Finnegan in 2009 affirmed that health care can be improved by adopting electronic health records [12]. For a doctor it reduces time spent on paper work. Patients can get information, benefit from it without deep knowledge of medical terms [24].

The idea of electronic health records dates back to 50 years. Lawrence weed laid foundation for problem solving by computerized patient records PROMIS (patient reported outcomes measurement system) to standardize quality of care. The resulting product Problem oriented medical records was introduced in 1970. It took almost 6 hours to complete a single task. By 1974 it supported almost 30000 units and was used by 500 physicians. Harvard University released ambulatory version of electronic medical records between 1970 and 1980 and it was known as COSTAR [21].

Electronic health records have not penetrated in spite of all benefits. One of the reasons is lack of usability. Improving usability present many challenges which can be handled by experts. The challenges include difficulty crafting a system, skilled users, complex functionalities and critical tasks [36].

Although there is improvement in clinical workflow, but there exist severe challenges like streamlining of administrative process, reduction of paperwork, health professional collaboration, reduced cost, and access to patient information especially in technical and software aspects [44].

Main barriers to less adoption are increased concerns on physician's ability to input data, higher costs and less efficiency during data entry. These barriers lower usability and cause patient safety incidents [22].

User centred design holds supreme role in designing useable and efficient system. It is an important principle in designing which aims to enhance usability of products to achieve user satisfaction. The success of user centred design lies in understanding user environment, design and testing based on user objectives [35].

NISTIR 7741 is a user centred design guide line for creating a useable and user centred design. It guides developers in creating efficient and effective design. It provides guidance on how to develop a useable interface and essential elements to be considered for usability evaluation. NISTIR 7741 ensures that electronic health records are efficient, effective and satisfactory [33].

3. Methodology

The research explores link between usability, user satisfaction, effectiveness, and efficiency. Improving the usability of electronic health record enhances user satisfaction, efficiency and effectiveness which is according to NISTIR 7741 user centred design guidelines. Different factors effecting usability and patient satisfaction have been explored.

What is the satisfaction level of user with health care system?

1. Is there effective support available for illiterate patients?
2. Can availability of medical history enhance efficiency of decisions?

3.1 Hypothesis

1. Improving usability enhances user satisfaction with adequate training.
2. EHR can decreases administrative workload and improve efficiency of workers.
3. Medical history increases efficiency of decisions.

3.2 Procedure

Data has been collected from hospitals of Gujrat and Islamabad. Participants of research are doctors and patients from Gujrat while doctors and medical staff from SHIFA international hospital Islamabad.

A sample of 100 doctors and 150 patients has been selected from total population. In pre study questionnaires have been filled from doctors to investigate their satisfaction and efficiency of current system, usability of system and issues effecting usability and user satisfaction.

Education of patients vary from illiterate to M.Phil. Questionnaires have been filled from patients of different education to find issues due to difficult procedures, rising costs, less access to medical facilities, unavailability of information systems and tough language used in prescription and patient information leaflet.

EHR used at SHIFA International hospital Islamabad has been investigated. Twenty-five doctors and 20 members of medical staff are participants of research. Questions have been asked to find user satisfaction with interface, navigation, work flow and information security.

On the basis of results an interface of electronic health record has been proposed. Separate access has been provided to doctors and patients. Doctors are main users while patients have access to appointment details, prescription, patient information leaflet, medical reports and medication details.

Proposed system is tested with doctors and patients from Gujrat. Collected data is analysed by SPSS 0.21. T test is applied to find difference in satisfaction, efficiency and effectiveness in pre and post study. Results depict by improving usability user satisfaction, efficiency and effectiveness improves.

4. Analysis

Collected data is analysed by SPSS 0.21 which is a powerful analytical tool. T test has been used to find difference in usability, efficiency and effectiveness.

4.1 Research from SHIFA International Hospital Islamabad

Physicians give less satisfaction on system navigation, interface, workload reduction, simplicity of system, user friendliness and ease to learn and use. The graph below depicts physician's response to EHR being used there.

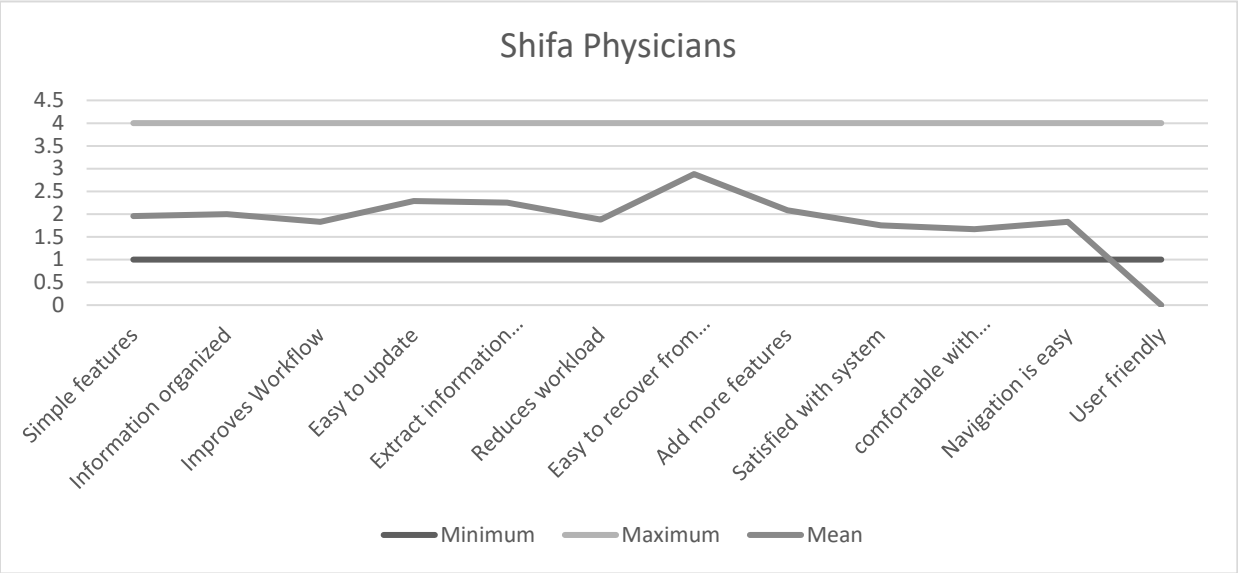


Figure 1: Shifa physician

Medical staff gave satisfaction on most of the features. The graph below depicts their response.

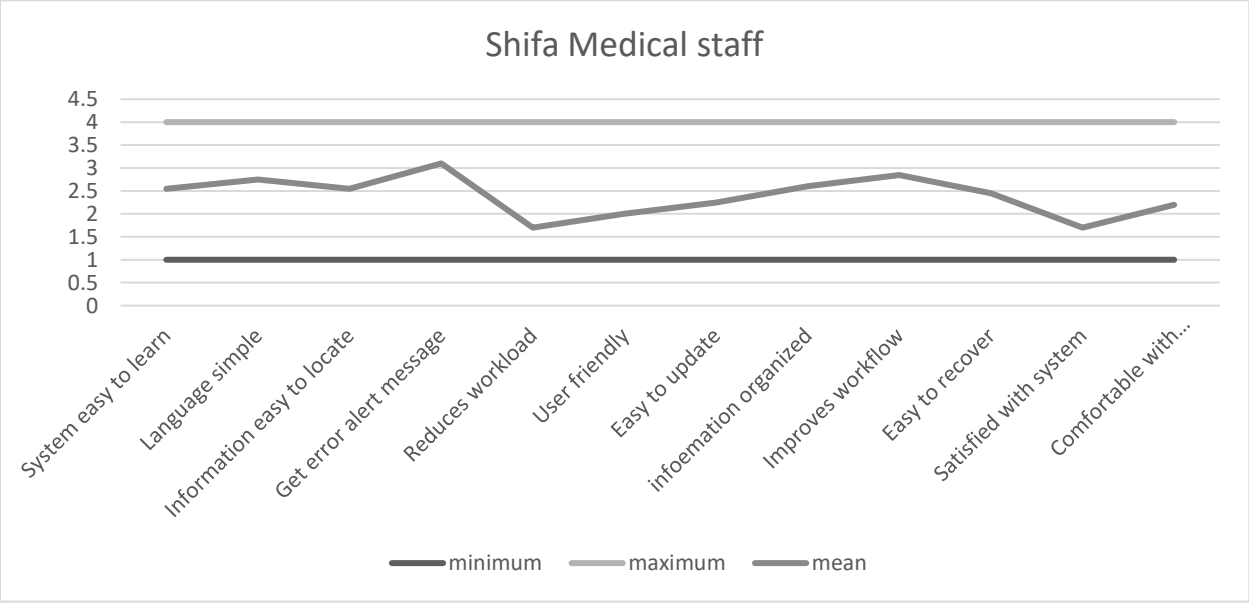


Figure 2: Shifa Medical staff

4.2 Research from Doctors of Gujrat

Different questions have been asked from doctors of Gujrat. The graph below depicts doctor's response to questions being asked from them in user study.

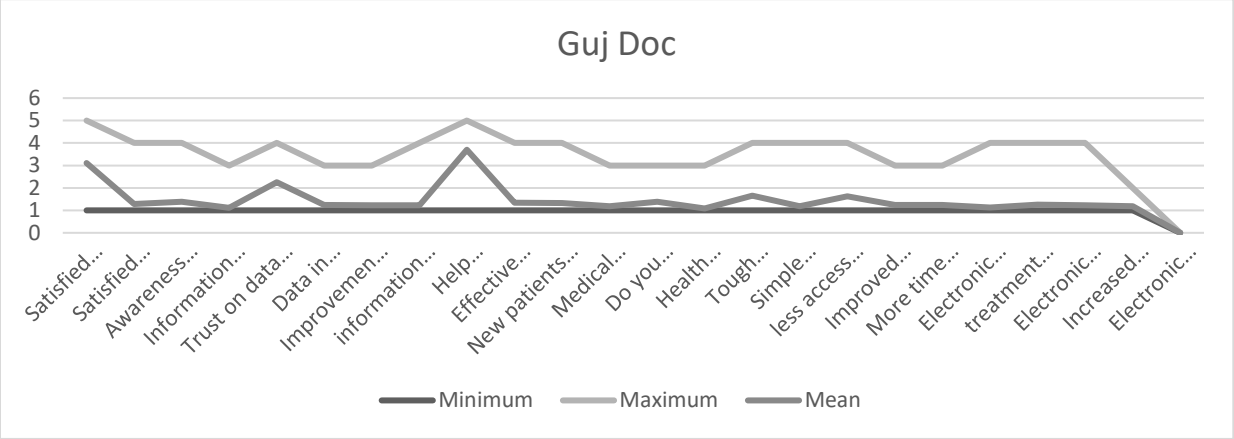


Figure 3: Gujrat Doctors

Paired sample statistics show improvement in user satisfaction, efficiency effectiveness after improving usability of system. T test gives a significant difference of -15.957 for user satisfaction, -17.698 for effectiveness, -1.956 for efficiency which is significant and negative.
The t test gives a difference of -22.538 and sig value .000 for usability which is significant and negative. It shows usability of system improve in post study.

4.3 Research from patients of Gujrat:
Research has been done from 150 patients selected from different hospitals on the basis of education. Paired sample statistics shows patient satisfaction and efficiency improve by improving usability in post study. The graph below shows patients response to different questions being asked from them.

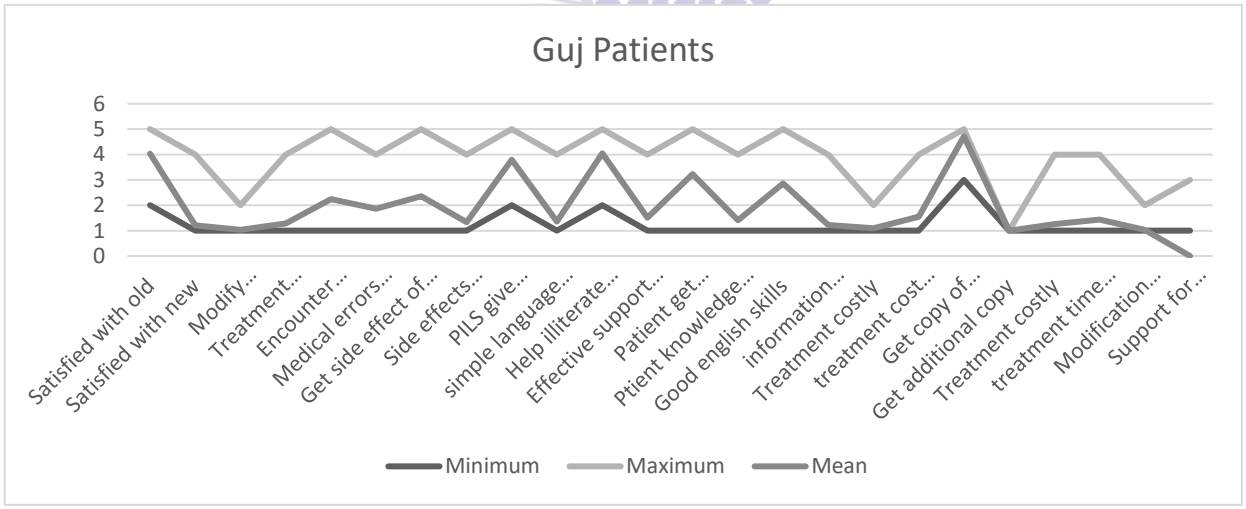


Figure 4: Gujrat patients

T test shows a difference of -40.92 for satisfaction, -57.26 for effectiveness, -6.35 for efficiency and -14.50 for usability in pre and post study. The values depict there exist significant difference in usability, user satisfaction, effectiveness and efficiency.
Satisfaction level of patients improve in post study. The graph below shows a comparison of patient satisfaction in pre and post study.

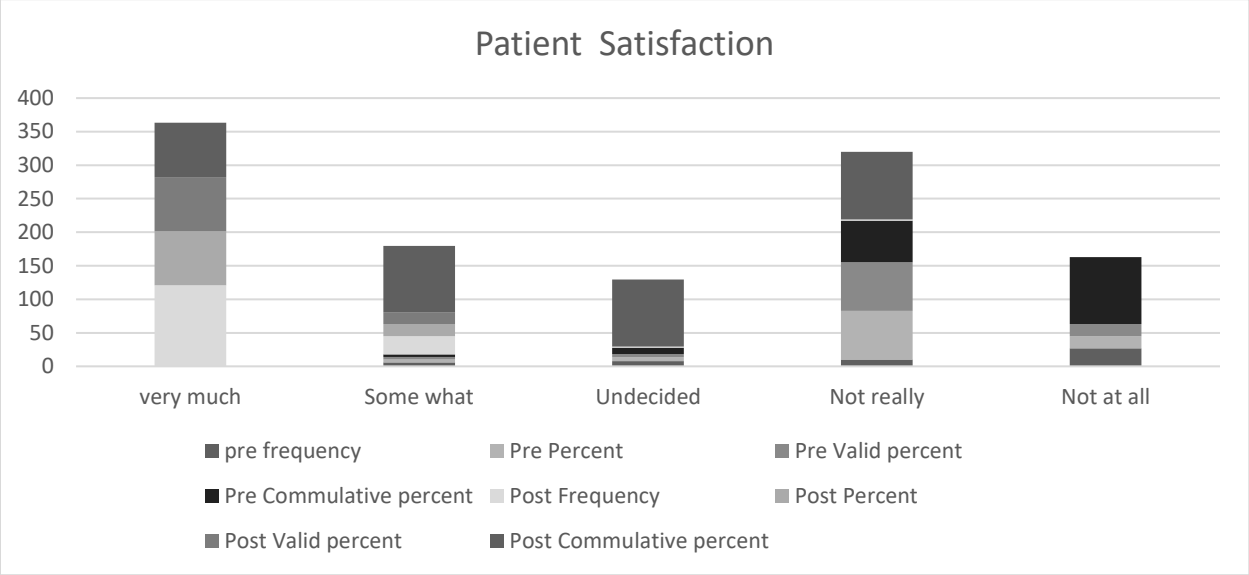


Figure 5: Gujrat patient satisfaction

Doctor satisfaction improves in post study. The graph below shows a comparison of doctor Satisfaction in pre and post study.

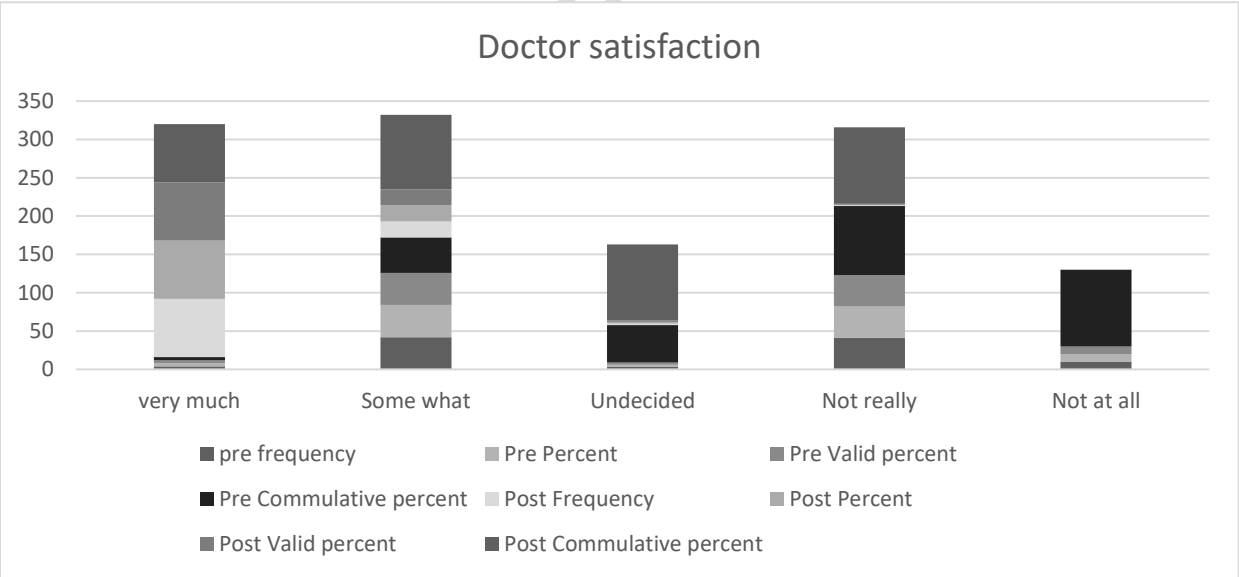


Figure 6: Gujrat Doctor Satisfaction

5. Limitations

Data collection was a difficult task. In order to collect data, distant hospitals were visited across cities. Doctors and medical staff took a long time in returning back questionnaire. It was difficult to fill questionnaires from illiterate patients because they had no knowledge of English and information technology applications. It was difficult to apply and upgrade system due to unavailability of modern and latest infrastructure in hospitals of Gujrat and less interest of medical staff.

Conclusion:

Integrating electronic health records can improve the quality of health. Improving usability of

Electronic Health records can enhance efficiency of health care and improve delivery of health services. Poorly designed EHR increase clinician's workload, cause documentation errors and reduce user satisfaction which lowers usability of health system. Improving usability by user-centred design, simplified workflows, intuitive interfaces, effective training, and continuous feedback make EHR more accessible and more efficient. Future developments should focus on involving end users in design and evaluation process while ensuring that EHRs support clinical decision-making without creating unnecessary burdens. Ultimately, prioritizing usability in EHR design can improve health professionals' experiences, enhance patient safety and contribute to better overall healthcare outcomes.

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