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Adoption of electronic health records in Saudi Arabia hospitals: Knowledge and usage

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ABSTRACT

Background: Saudi Arabia is paying a high attention to medically serve patients through advanced healthcare including: electronic health records (EHR). It is an electronic version of patient medical history that may incorporate essential administrative, clinical, laboratorial, radiological information. Locally, there were many researches and studies conducted to measure the awareness and implementation of e-health technologies including EHRs in Saudi Arabia. However, the aim of this research is to investigate the knowledge and usage levels of EHRs among different health care providers in Saudi Arabia.

Materials and Methods: By using a survey, this cross-sectional study is conducted to examine the knowledge and usage levels of EHRs among different health care providers at different sized hospitals from different provinces in Saudi Arabia. Statistical Analysis System software was employed in this study's analysis.

Results: There were 521 participants from different healthcare occupations involved to examine the knowledge and usage levels of EHRs in Saudi Arabia. 84.84 % of those participants are Saudis while 15.16 % of them are non-Saudis. 54.52 % of the participants are males while 45.48 % of them are females. Most participants were in the age group 31–40 years.

Conclusions: It is showing a high rate of knowledge and usage levels among both Saudi and non-Saudi healthcare providers in Saudi Arabia. Also, the using of EHRs for patients' services in hospitals have been increased including: laboratory reports, medication prescription, following up, and hospitalization. However, there might be a little lack of participants' skills of using EHRs because of the lack of attending training programs of EHRs.

1. Introduction

Electronic health records (EHR) is an electronic version of patient medical history that may incorporate essential administrative, clinical, laboratorial, radiological information. According to the World Health Organization (WHO), EHR is a type of technology associated with providing lifelong access to patient health information, particularly their emergency, outpatient, and inpatient encounters (WHO, 2015). Also, American Health Information Technology stated that EHR is therefore seen as a patient-centered real-time record that makes patient information securely and instantly available to authorized users (HealthIT, 2019).

EHRs are slowly replacing paper-based methods and thus even becoming the major information system in healthcare centers in the modern world (Evans, 2016; Graber et al., 2017). In addition, electronic health information facilitates storing and distribution of invaluable health information within various healthcare actors. EHR increases patient care by improving the clarity of medical records' accuracy and thus de-escalating the likelihood of medical error (Evans, 2016; Graber et al., 2017). Moreover, EHRs help the health care organization in managing the work flow and it is also used in order to improve the quality of care and patient safety (Evans, 2016; AHRQ, 2022).

In general, components of an EHR can be divided into four types of components including: patient management, clinical, Laboratory, and radiology components (HealthIT, 2019). Patient management components include administrative, demographics, and billing data. Clinical components include medical history, vital

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signs, medications, consults, immunization, progress and nurses' notes. Laboratory components include lab and test results. Radiology components include radiology images (HealthIT, 2019).

As a brief history of EHR, EHR began in 1960 s by Dr. Lawrence Weed as he developed the problem oriented medical records (POMR). During that time doctors use any type of template they like to record the information of the patient (Weed, 1968; Simons et al.2016). In 1972 the first electronic health records have been recognized (Schultz et al, 1971; Barnett, 1976; Pryor et al, 1983; Stead and Hammond, 1988; Evans, 2016). In 1990′s, Institute of Medicine started to use electronic version of medical record replacing paper-based medical record (Institute of Medicine, 1997; Evans, 2016). Since that, EHR is preferred more than paper-based records and the developing of it became massive. According to PEW, a survey on using EHR in the USA in 2021 concluded that 67 % patients are supporting medical information exchange among healthcare providers while 17 % do not support and 16 % do not care (PEW, 2021).

There are many advantages of EHRs including: enhancing access to healthcare (El-Kareh et al., 2013; Graber et al., 2017), enabling patients' information gathering and access (Yaraghi, 2015; Graber et al., 2017), facilitating the display and organization of health data (El-Kareh et al., 2013; Sittig et al., 2015), assisting in clinical decision-making (Barnett et al., 1987; Bright et al., 2012; Graber et al., 2017), helping in selection of a testing strategy (El-Kareh et al., 2013), enhancing reliable follow-up, enhancing collaboration for diagnosis (El-Kareh et al., 2013; Graber et al., 2017), enhancing telehealth (Hersh et al., 2006; Graber et al., 2017), and enhancing the measurement of diagnostic performance and timely feedback provision (El-Kareh et al., 2013; Graber et al., 2017).

In contrast, there are a few disadvantages of EHRs including: leading to inaccurate documentation (Singh et al., 2007; Singh et al., 2010; Callen et al., 2012; Graber et al., 2017), time-consuming (Sinsky et al., 2016), and problems of copying and pasting information (Sheehy et al., 2014; Graber et al., 2017).

Globally, status of EHRs is always in continuous development. However, different status of EHRs in different countries in the world depends on different standards in those countries (Commonwealth Fund, 2020).

In the United states of America, around 96 % of non-government hospitals and 84 % of office-based physicians have adopted EHRs in 2017. Also, 80 % of the hospitals have adopted EHRs with higher level of technological capabilities such as tracking the patient demographics, information and number of medications, clinical notes and instructions and tracking other related information such as medication orders, laboratory tests and results of the tests and scans of the patient (Commonwealth Fund. 2020).

In England, by 2015, all the patient records in England are computerize uploading the prescriptions and booking the appointments online. Also, in 2016, the health care professionals were obliged to provide patient the access to the details and records of themselves including the information related to the diagnosis, medication, treatment and immunizations and test and scan results on the online platforms. It is essentially done in order to make the medical and health detail easily accessible and understandable any time and in any medical institution (Thorlby, 2020; Commonwealth Fund. 2020).

In Australia, Australian health ministry have established Australian Digital Health Agency in 2016. The major responsibility of the agency is related to the digital health strategy of the country. In 2019, all the Australians has my health record got created giving the privilege to the patients to see their health data any time (Glover, 2020; Commonwealth Fund, 2020).

In France, EHR has covered around 1,882,503 patients by 2018 and 732 hospitals in the same year as well. They provided unique electronic identifier to the health care professionals and the patient, that can be helpful in accessing to information by any professional and can enter the information related to the patient to it (Zaleski, 2020; Commonwealth Fund, 2020).

Locally, there were many researches and studies conducted to measure the awareness and implementation of e-health technologies including EHRs in Saudi Arabia (Youssef and Alharthi, 2013; Almaiman et al., 2014; Al-Nasser et al., 2014; Almuayqil et al., 2016; Zaman et al., 2018; Alshammari, 2019; Amin et al., 2020; Medani et al., 2020; Albarrak et al., 2021; Sayed, 2021). According to all these researches and studies, Saudi Arabia is paying attention to the development of all health care services including e-health technologies as well as EHRs. However, even if Saudi Arabia has made progress in implementing e-health, more has to be done to make the implementation better (Alshammari, 2021).

Therefore, the aim of this research is to investigate the knowledge and usage of electronic health records (EHRs) among different health care providers at different sized hospitals from different provinces in Saudi Arabia.

2. Materials and methods

2.1. Study design

This cross-sectional study is conducted to examine the knowledge and usage of EHRs among different health care providers at different sized hospitals from different provinces in Saudi Arabia. The approval of conducting this study was obtained from the Ministry of Health (IRB Log No. 22-279E). Then, an online survey was sent to different healthcare providers at different sized governmental and private hospitals across thirteen provinces in Saudi Arabia. Finally, data were collected and analyzed.

2.2. Study survey

Survey questions were created, designed, and pilot-tested on 20 healthcare providers. Then, they have been edited and developed to suit the investigation of this study, which is knowledge and usage of EHRs among different health care providers at different sized hospitals from different provinces in Saudi Arabia. The final version of the survey contains two major sections. Questions of section I were about general information including: demographics, place of work, and occupation while questions of section II were examining knowledge and practical usage EHRs.

2.3. Study subjects

Healthcare providers in Saudi Arabia are qualified to respond this survey. Participants did not receive any incentives for responding this survey, which was voluntary. The online survey along with approval number from Saudi Ministry of Health were sent to the participants as well as all related information related to the survey including contact details of the of the researcher.

2.4. Study analysis:

Collected data were analyzed by using different descriptive and inferential methods and techniques to be displayed as frequency and percentage of responses. Statistical Analysis System software (SAS version 9.4) was employed in this study's analysis. P-value indicates the association among variables. So, to determine the relationship between variables, Chi-Square were used. Statistical significance was defined as a p-value of 0.05.

3. Results:

There were 521 participants in this cross-sectional study is to examine the knowledge and usage of EHRs among different health care providers. 84.84 % of those participants are Saudis while 15.16 % of them are non-Saudis. 54.52 % of the participants are males while 45.48 % of them are females. Most participants were in the age group 31–40 years (Table 1).

Different participants from different occupations of health care providers were participated in this cross-sectional study including: physicians, health practitioners, health engineers, health administrators, and other health professions (Table 2). Also, the participated health care providers in this study are different sized governmental and private hospitals across thirteen provinces in Saudi Arabia including: Riyadh, Madinah, Qasim, Eastern, Tabouk, Aseer, Makkah, Hael, Jazan, Jowf, Baaha, Najran, and Northern Borders Provinces (Table 2).

The knowledge level of electronic health records among health care providers in Saudi Arabia shows high rates. The majority of the Saudi and non-Saudi healthcare providers, who participated in this study, know EHR and its significance to health care. All p-values are < 0.05 showing statistically significant association (Table 3).

Also, the usage level of electronic health records among health care providers in Saudi Arabia shows high rates. The majority of those participants know how to use EHR and technology of it. All p-values are < 0.05 showing statistically significant association (Table 4).

Table 2
Distribution of participants by occupations and place of work:

		Saudi and Non-Saudi Health Care Provider
Occupation	Physicians	107 (20.54 %)
	Health practitioners	247 (47.41 %)
	Health engineers	60 (11.52 %)
	Health administrators	50 (9.59 %)
	Other health professions	57 (10.94 %)
Total		521 (100 %)
Place of Work	Riyadh Province	148 (28.41 %)
	Madinah Province	58 (11.13 %)
	Qasim Province	57 (10.94 %)
	Eastern Province	40 (7.68 %)
	Tabouk Province	40 (7.68 %)
	Aseer Province	33 (6.33 %)
	Makkah Province	26 (4.99 %)
	Hael Province	26 (4.99 %)
	Jazan Province	25 (4.80 %)
	Jowf Province	19 (3.65 %)
	Baaha Province	18 (3.45 %)
	Najran Province	17 (3.26 %)
	Northern Borders Province	14 (2.69 %)
Total		521 (100 %)

4. Discussion:

In general, this cross-sectional study shows high rates of knowledge as well as usage levels among health care providers in Saudi Arabia. There were 521 participants of this study from different hospitals of different provinces in Saudi Arabia. Of those, 442 (84.84 %) are Saudi participants and 79 (15.16 %) are non-Saudi participants. Of Saudi participants, 234 (44.92 %) are males and 208 (39.92 %) are females while 50 (9.60 %) are males and 29 (5.56 %) are females of non-Saudi participants (Table1).

The age groups of participants are $\leq$ 20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, and $\geq$ 71 years constituted in Saudi participants as 4.61 %, 16.70 %, 34.16 %, 14.59 %, 8.45 %, 4.22 %, and 2.11 % respectively and in non-Saudi participants as 0.76 %, 2.88 %, 6.14 %, 2.69 %, 1.54 %, 0.77 %, and 0.38 % respectively (Table1).

In order to get a wide perception of this cross-sectional study, there was a diversity of Saudi and non-Saudi healthcare providers that participated including: 107 physicians (20.54 %), 247 health practitioners (47.41 %) 60 health engineers (11.52 %), 50 health administrators (9.59 %), and 57 other health professions (10.94 %) (Table 2).

Moreover, those participants were from different sized governmental and private hospitals across thirteen provinces in Saudi Arabia including: Riyadh (28.41 %), Madinah (11.13 %), Qasim (10.94 %), Eastern (7.68 %), Tabouk (7.68 %), Aseer (6.33 %), Makkah (4.99 %), Hael (4.99 %), Jazan (4.80 %), Jowf (3.65 %), Baaha (3.45 %), Najran (3.26 %), and Northern Borders (2.69 %) Provinces (Table 2).

According to the results of this study, knowledge level of EHR is high among healthcare providers in Saudi Arabia (Table 3). All p-values are < 0.05 showing statistically significant association. 430 (82.53 %) of Saudi participants are aware of EHR compared to 65 (12.48 %) of non-Saudis. However, the number of Saudi participants, who believed that EHR is important, is 426 (81.77 %) while 63 (12.09 %) of non-Saudis (Table 3). 398 (79.39 %) of Saudi participants believed EHR saves time in hospital while 63 (12.09 %) of non-Saudis do. Also, 388 (74.47 %) of Saudi participants believed EHR reduce medical errors in hospital while 59 (11.32 %) of non-Saudis do. Leading to 421 (80.80 %) of Saudi participants are strongly believed that EHR can replace paper records in hospitals while 71 (13.63 %) of non-Saudi participants do (Table 3).

Moreover, 332 (63.72 %) of Saudi participants are interested in the functioning of EHR compared to 51 (9.79 %) of non-Saudis. However, only 269 (51.63 %) of Saudi participants attend training programs for using EHR compared to 32 (6.14 %) of non-Saudis leading to the lack of skills of using EHR (Table 3).

Table 1
Distribution of participants by gender and age:

		Health Care Provider						Total
		Saudi			Non-Saudi			
		Male	Female	Total	Male	Female	Total	
Age	**$\leq$ 20**	13 (2.50 %)	11 (2.11 %)	24 (4.61 %)	2 (0.38 %)	2 (0.38 %)	4 (0.76 %)	28 (5.37 %)
	21–30	46 (8.83 %)	41 (7.87 %)	87 (16.70 %)	10 (1.92 %)	5 (0.96 %)	15 (2.88 %)	102 (19.58 %)
	31–40	94 (18.04 %)	84 (16.12 %)	178 (34.16 %)	20 (3.84 %)	12 (2.30 %)	32 (6.14 %)	210 (40.30 %)
	41–50	40 (7.68 %)	36 (6.91 %)	76 (14.59 %)	10 (1.92 %)	4 (0.77 %)	14 (2.69 %)	90 (17.28 %)
	51–60	23 (4.42 %)	21 (4.03 %)	44 (8.45 %)	4 (0.77 %)	4 (0.77 %)	8 (1.54 %)	52 (9.99 %)
	61–70	12 (2.30 %)	10 (1.92 %)	22 (4.22 %)	3 (0.58 %)	1 (0.19 %)	4 (0.77 %)	26 (4.99 %)
	$\geq$ 71	6 (1.15 %)	5 (0.96 %)	11 (2.11 %)	1 (0.19 %)	1 (0.19 %)	2 (0.38 %)	13 (2.49 %)
Total		234 (44.92 %)	208 (39.92 %)	442 (84.84 %)	50 (9.60 %)	29 (5.56 %)	79 (15.16 %)	521 (100 %)

Table 3
Distribution of knowledge levels among participants:

Knowledge Question	Health Care Provider				Total	p-value
	Saudi		Non-Saudi			
	Yes	No	Yes	No		
Do you know electronic health records (EHR)?	430 (82.53 %)	12 (2.30 %)	65 (12.48 %)	14 (2.69 %)	521 (100 %)	0.001
Is EHR important in the hospital?	426 (81.77 %)	16 (3.07 %)	63 (12.09 %)	16 (3.07 %)	521 (100 %)	0.001
Does EHR save time in the hospital?	398 (76.39 %)	44 (8.45 %)	63 (12.09 %)	16 (3.07 %)	521 (100 %)	0.003
Does EHR reduce medical errors in the hospital?	388 (74.47 %)	54 (10.37 %)	59 (11.32 %)	20 (3.84 %)	521 (100 %)	0.022
Can EHR replace paper records in hospital?	421 (80.80 %)	21 (4.03 %)	71 (13.63 %)	8 (1.54 %)	521 (100 %)	0.001
Are medical stuff interested in the functioning of EHR?	332 (63.72 %)	110 (21.11 %)	51 (9.79 %)	28 (5.38 %)	521 (100 %)	0.041
Do you attend training program for using EHR?	269 (51.63 %)	173 (33.21 %)	32 (6.14 %)	47 (9.02 %)	521 (100 %)	0.032

Table 4
Distribution of usage levels among participants:

Usage Question	Health Care Provider				Total	p-value
	Saudi		Non-Saudi			
	Yes	No	Yes	No		
Do you use a computer in the hospital?	422 (80.99 %)	20 (3.84 %)	71 (13.63 %)	8 (1.54 %)	521 (100 %)	0.001
Do you use EHR in the hospital?	377 (72.35 %)	65 (12.48 %)	56 (10.75 %)	23 (4.42 %)	521 (100 %)	0.040
Is it easy to use EHR in the hospital?	394 (75.63 %)	48 (9.21 %)	57 (10.94 %)	22 (4.22 %)	521 (100 %)	0.010
Does EHR is used for laboratory reports?	395 (75.82 %)	47 (9.02 %)	61 (11.70 %)	18 (3.46 %)	521 (100 %)	0.001
Does EHR is used for medication prescription?	404 (77.55 %)	38 (7.29 %)	63 (12.09 %)	16 (3.07 %)	521 (100 %)	0.001
Does EHR is used for following up?	401 (76.97 %)	41 (7.87 %)	63 (12.09 %)	16 (3.07 %)	521 (100 %)	0.001
Does EHR is used for hospitalization?	395 (75.82 %)	47 (9.02 %)	62 (11.90 %)	17 (3.26 %)	521 (100 %)	0.001
Do medical stuff use EHR without any assistance?	344 (66.03 %)	98 (18.81 %)	55 (10.56 %)	24 (4.60 %)	521 (100 %)	0.033
Is the use of EHR safe for privacy of patient information?	411 (78.89 %)	31 (5.95 %)	64 (12.28 %)	15 (2.88 %)	521 (100 %)	0.002
Is the use of EHR faster than conventional method?	416 (79.84 %)	26 (4.99 %)	71 (13.63 %)	8 (1.54 %)	521 (100 %)	0.001
Should EHR be regularly upgraded?	425 (81.57 %)	17 (3.26 %)	71 (13.63 %)	8 (1.54 %)	521 (100 %)	0.045
Is the maintenance of EHR quick?	315 (60.46 %)	127 (24.38 %)	49 (9.40 %)	30 (5.76 %)	521 (100 %)	0.048

On the knowledge level of EHR, this cross-sectional study showed that the majority of Saudi and non-Saudi health care providing participants, from different hospitals of different provinces in Saudi Arabia, have nearly a complete knowledge of EHR. Also, almost all participants agreed on the benefit of using EHR to save time in the hospitals and reduce medical errors. Saudi participants prefer activating EHR in the hospitals more than non-Saudi participants. Although, Saudi participants attend training program for using EHR compared to non-Saudis, there is more need of attending EHR training program in order to avoid the lack of EHR skills among health care providers.

Like knowledge level, usage level of EHR is high among healthcare providers in Saudi Arabia (Table 4). All p-values are < 0.05 showing statistically significant association. 422 (80.99 %) of Saudi participants are using computers at hospitals compared to 71 (13.63 %) of non-Saudis. However, because not all categories of health care providers need to use EHR at hospitals and it is considered as a new technology to introduce that needs adoption, the number of Saudi participants who are using EHR at hospitals decreased to be 377 (72.35 %) as well as 56 (10.75 %) of non-Saudis. Fortunately, a high number of Saudi, 394 (75.63 %), and non-Saudi, 57 (10.94 %), participants believed that EHR is easy to install, activate and used (Table 4).

According to the results, the majority of both Saudi and non-Saudi healthcare providing participants, from different hospitals of different provinces in Saudi Arabia, strongly believe that EHR is highly used for laboratory reports, 87.52 %, medication prescription, 89.64 %, following up, 89.06 %, and hospitalization, 87.72 %, in the hospitals. However, 344 (66.03 %) of Saudi participants think medical stuff can use EHR without any assistance compared to 55 (10.56 %) of non-Saudis (Table 4). Leading to the same results of Table 2 regarding the need of attending training programs for using EHR to avoid the lack of skills of using EHR.

Regarding to the technology of EHR including: privacy protection, speed, upgrading, and maintenance, most Saudi and non-Saudi healthcare providing participants, from different hospitals of different provinces in Saudi Arabia, strongly agreed that EHRs in the hospitals are safe, 91.17 %, faster than conventional method, 93.47 %, and should be regularly upgraded, 95.20 %. However, quickness of EHR maintenance is not satisfied to 315 (60.46 %) Saudi participants compared to 49 (9.40 %) non-Saudi participants (Table 4).

On the usage level of EHR, this cross-sectional study showed that the majority of Saudi and non-Saudi health care providing participants, from different hospitals of different provinces in Saudi Arabia, have the welling and ability using of EHR in the hospitals. Also, almost all participants confirmed that EHR is used for laboratory reports, medication prescription, following up, and hospitalization in the hospitals. Although, most of the both Saudi and non-Saudis participants agreed that EHRs in the hospitals are safe, faster than conventional method, and should be regularly upgraded, a high number of those participants agreed that maintenance EHR should be treated quickly.

Finally, there were several studies on EHR in Saudi Arabia (Alshammari, 2021). However, this cross-sectional study investigated the knowledge and usage levels among health care providers in different categories of hospitals in different provinces in Saudi Arabia. It is showing a high rate of knowledge and usage levels among both Saudi and non-Saudi health care providers in Saudi Arabia. EHRs have many benefits, some of which are as follows: improving access to healthcare, facilitating patient information gathering and access, displaying and organizing health data, helping clinical decision-making, assisting in the choice of a testing strategy, enhancing reliable follow-up, enhancing collaboration for diagnosis, enhancing telehealth, and improving the measurement of diagnostic performance and prompt feedback provision.

5. Conclusion:

Globally, status of EHRs is always in continuous development. However, different status of EHRs in different countries in the world depends on different standards in those countries. Locally, Saudi Arabia is paying a high attention to serve patients though EHRs. There were many researches and studies conducted to measure the awareness and implementation of e-health technologies including EHRs in Saudi Arabia. However, this cross-sectional study investigated the knowledge and usage levels of EHRs on 521 health care providing participants from different sized hospitals from different provinces in Saudi Arabia. The findings of this study showed that knowledge and usage levels of EHRs have been increased from the past years. Also, the using of EHRs for patients' services in hospitals have been increased including: laboratory reports, medication prescription, following up, and hospitalization. However, there might be a little lack of participants' skills of using EHRs because of the lack of attending training programs of EHRs.

6. Recommendation

It is recommended that more exploratory and follow-up research be carried out to explore the availability and quality of EHR at the hospitals in Saudi Arabia and the services that are offered to both patients and healthcare providers.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jksus.2022.102470.

References

Agency for Healthcare Research and Quality (AHRQ). 2022. Electronic Medical Record Systems. www.ahrq.gov Accessed July 25, 2022.

Albarrak, A.I., Mohammed, R., Almarshoud, N., Almujalli, L., Aljaeed, R., Altuwaijiri, S., Albohairy, T., 2021. Assessment of physician's knowledge, perception and willingness of telemedicine in Riyadh region, Saudi Arabia. J. Infect. Public Health 14 (1), 97–102. https://doi.org/10.1016/j.jiph.2019.04.006.

Almaiman, A., Bahkali, S., Alfrih, S., Househ, M., El Metwally, A., 2014. The use of health information technology in saudi primary healthcare centers. Stud. Health Technol. Inform. 202, 209–212.

Almuayqil, S., Atkins, A.S., Sharp, B., 2016. Ranking of e-health barriers faced by Saudi Arabian citizens, healthcare professionals and IT specialists in Saudi Arabia. Health 8 (10), 1004–1013. https://doi.org/10.4236/health.2016.810104.

Al-Nasser, L., Al-Ehaideb, A., Househ, M., 2014. Assessing the current state of dental informatics in saudi arabia: the new frontier. Stud. Health Technol. Inform. 202, 165–168.

Alshammari, F., 2019. Perceptions, preferences and experiences of telemedicine among users of information and communication technology in Saudi Arabia. Journal of Health Informatics in Developing Countries 13 (1).

Alshammari, M.H., 2021. Electronic-health in Saudi Arabia: A Review. International Journal of Advanced and Applied Sciences 8 (6), 1–10 https://doi.org/10.21833/ijaas.2021.06.001.

Amin, J., Siddiqui, A.A., Al-Oraibi, S., Alshammary, F., Amin, S., Abbas, T., Alam, M.K., 2020. The potential and practice of telemedicine to empower patient-centered healthcare in Saudi Arabia. International Medical Journal 27 (2), 151–154.

Barnett, G.O., Cimino, J.J., Hupp, J.A., Hoffer, E.P., 1987. DXplain. An evolving diagnostic decision-support system. JAMA 258 (1), 67–74. https://doi.org/10.1001/jama.1987.03400010071030.

Barnett, G.O. Computer-stored ambulatory record (COSTAR). 1976. U.S. Dept. of Health, Education, and Welfare, Public Health Service, Health Resources Administration, National Center for Health Services Research in [Rockville, Md.]; 1976. 40 p.

Bright, T.J., Wong, A., Dhurjati, R., Bristow, E., Bastian, L., Coeytaux, R.R., Samsa, G., Hasselblad, V., Williams, J.W., Musty, M.D., Wing, L., Kendrick, A.S., Sanders, G. D., Lobach, D., 2012. Effect of clinical decision-support systems: a systematic review. Ann. Intern. Med. 157 (1), 29–43. https://doi.org/10.7326/0003-4819-157-1-201207030-00450.

Callen, J.L., Westbrook, J.I., Georgiou, A., Li, J., 2012. Failure to follow-up test results for ambulatory patients: a systematic review. J. Gen. Intern. Med. 27 (10), 1334–1348. https://doi.org/10.1007/s11606-011-1949-5.

Commonwealth Fund. 2010. International Profiles of Health Care Systems. www.commonwealthfund.org Accessed Aug 15, 2022.

El-Kareh, R., Hasan, O., Schiff, G.D., 2013. Use of health information technology to reduce diagnostic errors. BMJ Qual. Saf. 22 (Suppl 2), ii40–ii51.

Evans, R.S., 2016. Electronic Health Records: Then, Now, and in the Future. Yearbook of medical informatics, Suppl 1 (Suppl 1), S48–S61 https://doi.org/10.15265/IYS-2016-s006.

Glover, L. 2020. The Australian Health Care System. International Profiles of Health Care Systems. Commonwealth Fund. 2020.

Graber, M.L., Byrne, C., Johnston, D., 2017. The impact of electronic health records on diagnosis. Diagnosis (Berlin, Germany) 4 (4), 211–223. https://doi.org/10.1515/dx-2017-0012.

Health Information Technology (HealthIT). 2019. Health IT and Health Information Exchange Basics. www.healthit.gov Accessed July 26, 2022.

Hersh, W.R., Hickam, D.H., Severance, S.M., Dana, T.L., Pyle Krages, K., Helfand, M., 2006. Diagnosis, access and outcomes: Update of a systematic review of telemedicine services. J. Telemed. Telecare 12 (Suppl 2), S3–S31. https://doi.org/10.1258/135763306778393117.

Institute of Medicine (US) Committee on Improving the Patient Record. 1997. Dick, R. S., Steen, E. B., & Detmer, D. E. (Eds.). The Computer-Based Patient Record: Revised Edition. National Academies Press (US). PMID: 25121222. Bookshelf ID: NBK233047. DOI: 10.17226/5306.

Medani, K.T., Ahmed, S.M., Sami, W., Ahmed, S.M., Mohamed, E.Y., Abdalla, S.M., Abdelrahman, H.H., 2020. Use of electronic health records among Saudi and Non - Saudi health providers - a comparative study at a secondary hospital, Saudi Arabia. JPMA. The. J. Pak. Med. Assoc. 70 (9), 1591–1595.

Pew Charitable Trusts (PEW). 2021. Most Americans Want to Share and Access More Digital Health Data. www.pewtrusts.org/en/ Accessed Aug 1, 2022.

Pryor, T.A., Gardner, R.M., Clayton, P.D., Warner, H.R., 1983. The HELP system. J. Med. Syst. 7 (2), 87–102. https://doi.org/10.1007/BF00995116.

Sayed, M.E., 2021. Knowledge, attitude and behaviour of dental health care providers towards health electronic record systems in Saudi Arabia. Health Info. Libr. J. 38 (3), 194–202. https://doi.org/10.1111/hir.12290.

Schultz, J.R., Cantrill, S.V., Morgan, K.G., 1971. An Initial Operational Problem Oriented Medical Record System—For Storage. Manipulation and Retrieval of Medical Data. https://doi.org/10.1145/1478786.1478822.

Sheehy, A.M., Weissburg, D.J., Dean, S.M., 2014. The role of copy-and-paste in the hospital electronic health record. JAMA Intern. Med. 174 (8), 1217–1218. https://doi.org/10.1001/jamainternmed.2014.2110.

Simons, S.M., Cillessen, F.H., Hazelzet, J.A., 2016. Determinants of a successful problem list to support the implementation of the problem-oriented medical record according to recent literature. BMC Med. Inf. Decis. Making 16, 102. https://doi.org/10.1186/s12911-016-0341-0.

Singh, H., Arora, H.S., Vij, M.S., Rao, R., Khan, M.M., Petersen, L.A., 2007. Communication outcomes of critical imaging results in a computerized notification system. Journal of the American Medical Informatics Association : JAMIA 14 (4), 459–466. https://doi.org/10.1197/jamia.M2280.

Singh, H., Thomas, E.J., Sittig, D.F., Wilson, L., Espadas, D., Khan, M.M., Petersen, L.A., 2010. Notification of abnormal lab test results in an electronic medical record: do any safety concerns remain? Am. J. Med. 123 (3), 238–244. https://doi.org/10.1016/j.amjmed.2009.07.027.

Sinsky, C., Colligan, L., Li, L., Prgomet, M., Reynolds, S., Goeders, L., Westbrook, J., Tutty, M., Blike, G., 2016. Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties. Ann. Intern. Med. 165 (11), 753–760. https://doi.org/10.7326/M16-0961.

Sittig, D.F., Murphy, D.R., Smith, M.W., Russo, E., Wright, A., Singh, H., 2015. Graphical display of diagnostic test results in electronic health records: a comparison of 8 systems. Journal of the American Medical Informatics Association : JAMIA 22 (4), 900–904. https://doi.org/10.1093/jamia/ocv013.

Stead, W.W., Hammond, W.E., 1988. Computer-based medical records: the centerpiece of TMR. M.D. computing : computers in medical practice 5 (5), 48–62.

Thorlby, R. 2020. The English Health Care System. International Profiles of Health Care Systems. Commonwealth Fund. 2020.

Weed, L.L., 1968. Medical records that guide and teach. N. Engl. J. Med. 278 (11), 593–600. https://doi.org/10.1056/NEJM196803142781105.

World Health Organization (WHO). 2015. Country has national Electronic Health Record (EHR). www.who.int Accessed July 25, 2022.
Yaraghi, N., 2015. An empirical analysis of the financial benefits of health information exchange in emergency departments. Journal of the American Medical Informatics Association: JAMIA 22 (6), 1169–1172. https://doi.org/10.1093/jamia/ocv068.
Youssef, A., Alharthi, H., 2013. Accuracy of the Charlson index comorbidities derived from a hospital electronic database in a teaching hospital in Saudi Arabia. Perspect. Health Inf. Manag. 10 (Summer), 1a.
Zaleski, I D. 2020. The French Health Care System. International Profiles of Health Care Systems. Commonwealth Fund. 2020.
Zaman, T.U., Raheem, T.M.A., Alharbi, G.M., Shodri, M.F., Kutbi, A.H., Alotaibi, S.M., Aldaadi, K.S., 2018. E-health and its transformation of healthcare delivery system in Makkah, Saudi Arabia. International Journal of Medical Research and Health Sciences 7 (5), 76–82.