

## Implication Of Health Informatics On The Healthcare Workers' Activities In Hospitals In Jeddah, Saudi Arabia

Hassen Alzhrani<sup>1</sup>, Bander Alyoubi<sup>1</sup>, Mohammed Assiri<sup>1</sup>, Ali  
Aljuaid<sup>1</sup>, Sattam Aljohani<sup>1</sup>, Khaled Awaji<sup>1</sup>, Abdullah  
Alrashed<sup>2</sup>, Abdulaziz Abdullah Aldosari<sup>3</sup>

<sup>1</sup> Directorate of Health Affairs in Jeddah, Ministry of Health, Saudi  
Arabia.

<sup>2</sup> King Abdulaziz Hospital Jeddah, Ministry of Health, Saudi Arabia.

<sup>3</sup> Wadi Al-Dawasir General Hospital, Ministry of Health, Saudi  
Arabia.

### Abstract

**Background:** health informatics have been used in the field of healthcare for quite a long time. Research investigations have since been conducted to examine various features around the use and application of health informatics. However, there is an apparent gap in the current literature in regard to comprehensive information about the effect of health informatics on the healthcare workers' practices in Saudi German Hospital, Jeddah.

**Aim:** the aim of this research was to evaluate the implication of health informatics on the healthcare workers' activities in Saudi German Hospital in Jeddah, Saudi Arabia.

**Methods:** this study applied cross-sectional quantitative research design. Upon seeking and receiving the ethical approval, a sample of 123 healthcare workers in Saudi German Hospital, Jeddah were recruited for data collection. Henceforth, data was collected using survey questionnaires, to which 105 (85.3%) responses were received. The collected data was then analyzed using three statistical tools of SPSS, including the descriptive statistics, Spearman's rank correlation

coefficient, multiple linear regression and multiple analysis of variance.

**Results:** this study found out that health informatics has two critical roles regarding the healthcare workers practices. This was indicated by 40.9% of the participants who strongly agreed that health informatics augments quality of healthcare services delivery and 41.9% of the participants who strongly agreed that health informatics enhances information quality. This study further established that health informatics has a statistically significant impact on the quality of patient care ( $r=502$ ;  $p=.000$ ), health workers competencies ( $r=522$ ;  $p=.000$ ), and patient safety ( $r=457$ ;  $p=.000$ ). Further, this research also observed that the perceived roles of health informatics was had statistically significant association with the healthcare workers' age ( $p=.023$ ) and education level ( $p=.033$ ).

**Recommendation:** there is a need for the healthcare administrations units to intensify the use of health informatics to improve the quality of healthcare service delivery as a function of the healthcare workers.

**Keywords:** health informatics, healthcare workers, healthcare services delivery, patient care.

## Introduction

### Background

Technology has lately revolutionized to almost every nook of the healthcare service delivery. Among the most widely applied technologies in healthcare are health informatics, notably the electronic health records (EHR) (Chakraborty, Ilavarasan & Edirippulige, 2021). Currently, every country across the globe is advancing towards the use of electronic health systems to improve the information storage and flow within their organizations (Tanwar, Parekh & Evans, 2020). And so, there has been a growing research interests in various concepts around the development and application of health information technology (Rahimi et al., 2018).

Many countries in the Middle East have equally made advancements towards the use of health information systems (Meri et al., 2018; Feldman, Buchalter & Hayes, 2018). In Jordan, for instance, a significant milestone was made towards the full realization of the health information system with the introduction of the Hakeem systems (Alsharo, Alnsour & Alabdallah, 2020). Nevertheless, apparent role of technology in healthcare was witnessed during the covid-19 pandemic when the healthcare services were overstretched (Mahajan, Singh & Azad, 2020). Of notable interest to this research is the application of technology in healthcare for storage and sharing of patient information and data. The health information system played critical role in managing patients' information in many countries including Saudi Arabia (Hassounah, Raheel & Alhefzi, 2020; Alghamdi, Alqahtani & Aldhahir, 2020; Alghamdi et al., 2021).

Scholars trace the development and testing of health informatics in healthcare to over 70 years back (Cesnik & Kidd, 2010). In the recent times, technology around health informatics has greatly improved, and is effectively applied in many areas of patient care, including clinical decision making, reduce risks of information loss, decrease costs of operation, data analysis, and improve nature of healthcare service delivery for patients' convenience (Siedlecki & Hixson, 2015; Persell et al., 2011; Kutney-Lee & Kelly, 2011; Salmond & Echevarria, 2017; Nguyen, Wang & Jack Li, 2018). Some of the relatively recent research also document the potential role of health informatics in promoting cancer care (Meropol, 2018). Indeed, the application of tools, such as the electronic health records have a vast impact in healthcare (Bae & Encinosa, 2016; Nijhawan et al., 2013). Schoener et al. (2018) indicates that the data storage by the electronic health system, notably health informatics, could help to inform future decisions to improve patient care.

Reid et al. (2021,) refers to health informatics as the integration of information and communication technologies with the available health knowledge to enhance patient care service delivery. Health informatics also encompasses the "clinical supportive network that is arranged and executed by high normalized measures and of incredible reproducibility" (Curtis et al., 2018). Empirical evidence shows that health informatics in nursing practices significantly

enhance patients' wellbeing and helps to evaluate staff requirements (Silow-Carroll et al., 2012). As such, nursing informatics give a reliable clue on how information technology can improve patient care practices. Another research done by Sayed (2021) showed that the electronic health records are important in collecting patients' data faster.

While there is vast evidence supporting the positive impact of health informatics in nursing care practices, some studies have also reported some challenges experienced in the course of health informatics. One of the recent investigations in Saudi Arabia, by ALSadrah (2020) reported that negative attitudes of the healthcare workers negatively affect the application of electronic medical records. At the same time, literature evidence has noted that the application of health informatics may face many significant barriers such as "loss of access to medical records transiently if computer crashes or power fails" (El Mahalli, 2015).

Despite the documented evidence in many parts of the world, little research has been done in Saudi Arabia regarding the role of health informatics in relation to patients' safety, competency of healthcare workers, and quality of patient care. Moreover, based on the extent of the investigations already presented in the literature, this study noted that there are still knowledge gaps in the role of health informatics in improving quality of patient care, health workers' competencies, and patients' safety in Saudi Arabia, and hence the need for this investigation.

### **Methods**

This study applied the cross-sectional quantitative study design. The survey questionnaires were administered to 123 healthcare workers in Saudi German Hospital in Jeddah. These participants were identified from the hospital records of employees at the human resources office.

The ethical approval was sought from the research and ethics committee of the university and the hospital. Data was then collected by using a pencil and paper technique due to the proximity of the research participants. The research questionnaire was designed to cover four main concepts, which were derived from the variables in the literature. The questionnaire had two

main sections. The first section was designed to collect data about the study participants' socio-demographic factors, including age, gender, level of education, department of work, and duration (years) of using health informatics. The other section was designed to collect data about the three discrete outcome features of applying health informatics. These outcome features included health workers competencies, patients' safety, and quality of patient care.

However, before the actual data collection, the research questionnaire was piloted among a volunteer sample of 10 participants to check the reliability statistics based on the internal consistencies of the items. Accordingly, the study reported a Cronbach's alpha of 0.89, which justified that the tool was reliable for collecting data regarding the named variables and for the stated constructs. Further, the construct validity was also assessed to examine whether the questionnaire items were relevant to the variables and constructs against which they targeted. This was done with the aid of an expert researcher within the university. It was found out that the questionnaire items adequately met the requirement feature of addressing the named variables, and suitable for the named research participants.

The collected data was analyzed using the SPSS version 26 by utilizing three statistical tests, including the descriptive statistics, Multiple Analysis of Variance (MANOVA), multiple linear regression, and Spearman's rho correlation. The Spearman's rho correlation was used over the use of Pearson's correlation since the instrument presented both ordinal scale data.

## **Results**

A total of 105 participants completed the survey. There were more males (60%) than females (40%). Most of the participants were between 31 and 40 years. Regarding level of education, 38.1% of the participants had diploma level and the least number (28.1%) had undergraduate level of education. Highest proportion of the participants (21%) worked in Pediatric unit while the least (5.7%) worked in the operation rooms.

**Table 1. Participants' sociodemographic characteristics**

<b>Variables</b>	<b>Frequencies (N)</b>	<b>Percentage (%)</b>
Age		
20 – 30	26	24.8
31 – 40	29	27.6
41 – 50	27	25.7
51 – 60	19	18.1
> 60	4	3.8
Gender		
Male	63	60
Female	42	40
Level of education		
College Diploma	40	38.1
University	35	33.3
undergraduate	30	28.6
Post graduate degree		
Department of Work		
Emergency care unit	9	8.6
Intensive care unit	18	17.1
Medical surgical unit	8	7.6
Operation rooms unit	6	5.7
Obes-gyn unit	14	13.3
Cardiac intensive care unit	15 22	14.3 21.0
Pediatric unit	13	12.4
Outpatient clinics		

Fifty participants (40.9%) strongly agreed and 35 (33.3%) agreed that health informatics augments quality of healthcare services delivery. Also, majority of the participants indicated that health informatics enhances information quality as 35.2% agreed and 41.9% strongly agreed to the idea. However, when it came to the role of health informatics on enhancing job satisfaction, majority gave mixed responses as 43.8% remained neutral. Negative reactions were noted in the healthcare workers perception of the health informatics in enhancing teamwork and job satisfaction as majority of the participants disagreed and strongly disagreed (Table 2).

**Table 2. Role of health informatics**

Item	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Health informatics augments quality of healthcare services delivery	3 (2.9)	3 (2.9)	14 (13.3)	35 (33.3)	50 (40.9)
Health informatics enhances information quality	2 (2.9)	5 (4.6%)	18 (17.1)	37 (35.2)	43 (41.9)
Health informatics enhances job satisfaction among the healthcare workers	4 (3.8)	9 (8.6)	46 (43.8)	13 (12.4)	33 (31.4)
Health informatics enhances patients' privacy	29 (27.6)	37 (35.2)	15 (14.3)	3 (2.9)	21 (20)
Health informatics promotes teamwork among health workers.	42 (40)	21 (20)	12 (11.4)	16 (15.2)	14 (13.3)

The MANOVA test was performed to examine whether health informatics had a statistically significant impact on the healthcare workers' competency, patient safety and quality of patient care. The Box's Test of Equality of Covariance Matrices (Table 3) shows that that the covariance matrices among the dependent variable are the same, and having no significant differences ( $p > .005$ ). Therefore, the assumptions of same covariance matrices were met.

**Table 3. Box's Test of Equality of Covariance Matrices**

Box's M	16.653
F	2.686
df1	6
df2	68349.373
Sig.	.013

Based on the Wilks' Lambda, it is evident that health informatics has a statistically significant and summative impact on the three outcome variables ( $p = .000$ ) (Table 4). As such, health informatics explains a significance variance in the three outcome variables.

**Table 4. Multivariate Test of MANOVA**

Special Issue On Multidisciplinary Research

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.975	1314.989 <sup>b</sup>	3.000	101.000	.000
	Wilks' Lambda	.025	1314.989 <sup>b</sup>	3.000	101.000	.000
	Hotelling's Trace	39.059	1314.989 <sup>b</sup>	3.000	101.000	.000
	Roy's Largest Root	39.059	1314.989 <sup>b</sup>	3.000	101.000	.000
Health informatics	Pillai's Trace	.436	26.005 <sup>b</sup>	3.000	101.000	.000
	Wilks' Lambda	.564	26.005 <sup>b</sup>	3.000	101.000	.000
	Hotelling's Trace	.772	26.005 <sup>b</sup>	3.000	101.000	.000
	Roy's Largest Root	.772	26.005 <sup>b</sup>	3.000	101.000	.000

Moreover, this study observed that health informatics has a statistically significant impact on the quality of patient care (p=.000), health workers competencies (p=.000), and patient safety (p=.000) (Table 5).

**Table 5. Tests of Between-Subjects Effects**

Source	Dependent Variable	Type III Sum of Squares	Mean Square	F	Sig.
Corrected Model	Quality of patient care	12.839 <sup>a</sup>	12.839	31.731	.000
	Health workers competencies	10.590 <sup>b</sup>	10.590	37.872	.000
	Patient Safety	10.168 <sup>c</sup>	10.168	28.137	.000
Intercept	Quality of patient care	776.572	776.572	1919.287	.000
	Health workers competencies	433.333	433.333	1549.722	.000
	Patient Safety	586.625	586.625	1623.285	.000
Health informatics	Quality of patient care	12.839	12.839	31.731	.000
	Health workers competencies	10.590	10.590	37.872	.000
	Patient Safety	10.168	10.168	28.137	.000

Health informatics has strongest impact on the health workers competencies (r=.522), which was followed by quality of patient care (r=.502), and finally patients' safety (r=.457). Overall, health informatics had statistically significant impact on the three variables (p=.000) at 99% confidence interval (Table 6).



Table 6. Pearson correlations of health informatics and Quality of patient care, healthcare workers’ competencies, and patient Safety

	Quality of patient care	Workers’ competencies	Patient Safety	Health Informatics
Quality of patient care	1	.010		
Workers’ competencies	.251**	1	.000	
Patient Safety	.592**	.334**	1	
Health Informatics	.502**	.522**	.457**	1
	.000	.000	.000	.000

Multiple linear regression was also conducted, and the model had a relatively low percentage of predicting the relationship among these variables ( $r^2=.105$ ). The model only describes 10% of the variance in the outcome variables described by the role of health informatics ( $p=.049$ ) at 95% confidence interval (Table 7).

Table 7. Multiple linear regression Model summary and ANOVA

	Sum of Squares	df	Mean Square	F	Sig.	R Square	R square adjusted
Regression	2.721	5	.544	2.318	.049 <sup>b</sup>	.105	.060
Residual	23.241	99	.235				
Total	25.962	104					

The coefficients of association show that age ( $p=.023$ ) and level of education ( $p=.000$ ) have a statistically significant effect on the role of healthcare informatics as perceived by the healthcare workers in Saudi German Hospital in Jeddah, Saudi Arabia (Table 8).

Table 8. Coefficients of association between the sociodemographic factors and health informatics

	Standardized Coefficients (β)	t	P value
--	-------------------------------	---	---------

Special Issue On Multidisciplinary Research

Age	.232	2.302	.023
Gender	-.089	-.902	.369
Education Level	.210	2.162	.033
Department of Work	.067	.694	.489
Duration of using health informatics	.096	.984	.327

**Discussion**

**Role of health informatics**

Health informatics has many significant roles, including augmenting the quality of healthcare service delivery, and improving information quality, and job satisfaction. Majority of the participants expressed a strong positive perception that health informatics improves healthcare service delivery. This outcome is, however, not unique to this study since the relationship between health informatics and quality of healthcare service delivery is highly explored in the literature (Abaidoo & Larweh, 2014; Bowman, 2013; Middleton et al., 2013; Herrin et al., 2012; Atasoy, Greenwood & McCullough, 2019; Moja et al., 2014). Tai-Seale et al. (2017) noted that electronic health records help to improve desktop medicine practices on different domains, such as effective communication with peers and patients.

According to Silow-Carroll, Edwards and Rodin (2012), electronic health records help to improve quality of healthcare service delivery from different angles and perspectives including:

“... the use of checklists, alerts, and predictive tools; embedded clinical guidelines that promote standardized, evidence-based practices; electronic prescribing and test-ordering that reduces errors and redundancy; and discrete data fields that foster use of performance dashboards and compliance reports... faster and accurate communication and streamlined processes...fewer duplicative tests, faster responses to patient inquiries, redeployment of transcription, and claims staff, more complete capture of charges, and federal incentive payments” (p. 40).

It was also noted that health informatics helps to improve quality of information in in Saudi German Hospital. Again, this outcome is not unique to this research. Previous studies have also noted that electronic health records help to improve the storage and retrieval of patients' clinical and medical information (Silow-Carroll, Edwards & Rodin, 2012; Atasoy, Greenwood & McCullough, 2019). Role of health informatics in improving quality of information can be closely tied to the use of electronic health records, which have taken shape in Saudi German Hospital, and many other hospitals in Saudi Arabia and beyond. On the same note, a review conducted by Ammenwerth, Schnell-Inderst and Hoerbst (2012) among the randomized controlled trials reported a significant improvement in many areas after using the electronic health record systems. One of the areas was a significant decrease in the office visit rates and slower increase in telephone contacts. These changes point towards the effectiveness of the health informatics in saving patients' information. Many other researchers have expressed the positive impact of health informatics on improving the quality of information (Hripcsak & Albers, 2013; Jensen, Jensen & Brunak, 2012).

However, a relatively smaller proportion of the health workers in Saudi German Hospital who reported that health informatics enhances their job satisfaction. In fact, most of the participants indicated that they were unsure if health informatics helped to improve satisfaction in their job. One of the reasons for the weak linkage between health informatics and job satisfaction among the healthcare workers in Saudi German Hospital are the reported barriers of effective adoption of health informatics in the literature. For instance, Ajami and Bagheri-Tadi (2013) noted many barriers, including malfunction, concerns over data security, negative attitude, and even high costs of installation and maintenance. Studies conducted in Saudi Arabia have also reported several barriers against the application of electronic health records, including legislative regulations, technical barriers, and employees' beliefs (Khalifa, 2013).

Most of the healthcare workers in in Saudi German Hospital indicted that health informatics does not enhance patients' safety. The negative perception could arise from the many negative challenges that face the use and adoption of health informatics,

such as insecurity (Kruse et al., 2017). Information security is one of the critical issues that affect the quality of trust of the information in electronic health records (Fernández-Alemán et al., 2013). The last issue focused on the role of health informatics in promoting teamwork among health workers, to which majority of the participants did not agree. Even though this study did not investigate the reasons why most healthcare workers feel that the health informatics does not promote teamwork, some previous literature reported otherwise (Iqbal, Syed-Abdul & Yu-Chuan Li, 2015).

### **Impact of health informatics on the quality of patients' care**

Health informatics helps to improve quality of patients' care in many aspects, including timely diagnosis, convenient medical care, patient safety, assessment for adjustments, and speed of access to medical care. Similarly, previous research studies already established that health informatics has a positive association with the quality of patient care service delivery (Sadoughi, Nasiri & Ahmadi, 2018; Rozenblum et al., 2013). Indeed, there is a large body of evidence that links the use of health informatics in clinical decision-making due to the readily available information on patients' records (Kruse et al., 2017; Singh et al., 2018; Rothman, Leonard & Vigoda, 2012; Forrest et al., 2014). From a different angle, Neves et al. (2018) explained that "providing patients with access to electronic health records (EHRs) has emerged as a promising solution to improve quality of care and safety" which is a key positive benefit that is realizable on the quality of patient care.

Health informatics directly helps to improve the speed of information access on electronic avenues, such as the e-health systems, which helps to increase chances of patients' adherence to medication and recovery, and reduce chances of medication-associated errors (Han et al., 2016; Kharrazi et al., 2021). Faster access to healthcare service is likely to translate into faster positive outcome among patients. Other benefits of using health informatics on the quality of patient care can also be linked to the levels of patients' satisfaction as an indicator of the healthcare service quality delivery. Many researchers have reported that health informatics helps to improve patients' satisfaction with the

quality of healthcare service delivered (Rozenblum et al., 2013; van Der Vaart et al., 2014). Rozenblum et al. (2013) showed that out of the included 20 randomized control trial, 40% did had a positive impact on patients' satisfaction.

### **Impact health informatics on the patients' safety**

Health informatics helps to improve patients' safety. The positive relationship between health informatics and patients' safety can be mirrored on many surfaces including the incidences of medication errors, patient safety predictors such as pressure ulcers, incidences of transfusion reaction count, faster to accurate patients' information and incidences of postoperative sepsis rate among patients who undergo surgical operations.

The use of health informatics, such as electronic health records, help to ensure that patients' clinical and medication information are accurately saved so as to evade errors (Hess et al., 2020; Vaidotas et al., 2019; Agrawal, 2009; Alex et al., 2016). Many studies have examined the relationship between the use of health informatics and the incidence of medication errors, and the outcomes is concurrently positive (Alex et al., 2016; Jindal & Raziuddin, 2018). Notably, Jindal and Raziuddin (2018) showed a significant reduction in the incidences of medication errors, wrong site surgery, improper dosage delivery to a patient, and wrong medication, by 50-60 per cent due to health informatics. **Researchers also** reported that the use electronic health records significantly helped to reduce the cases of medication errors among the admitted adult patients (Pettit et al., 2019; Ratwani et al., 2018)

Moreover, Alex et al. (2016) also provided strong evidence that the use of electronic health records helps to reduce chances of medication errors during patient care practices. Through a prospective randomized control trail, Alex et al. (2016, p. 32) reported that "the percentage of patients without medication errors within 72 hours of discharge was 93.8% on the intervention team compared with 40.2% on the control team ( $P < .0001$ )."

### **Impact health informatics on health workers competency**

The competencies of health workers were considered using different concepts, including abilities to understand patients'

critical needs, emotional skills, professional collaboration, clinical decision making, and overall professionalism. The study established a positive relationship between the use of health informatics and competencies of health workers, and literature outcomes uphold this observation (Zahabi, Kaber & Swangnetr, 2015; Dubovitskaya et al., 2017).

One of the widely reported ways of how electronic health records help to improve competency of the healthcare workers in Saudi German Hospital was noted in the clinical decision making. Sutton et al. (2020) also reported how the use of electronic health information technology helps in the management of clinical decision support systems. Many other studies have also noted a positive linkage between health information systems and professional work among the healthcare workers (Goldstein et al., 2017; Castaneda et al., 2015; Musen, Middleton & Greenes, 2021). Clinical decision making can also be done using data forecasting to provide reliable patients' treatment avenues.

Moreover, the healthcare workers in Saudi German Hospital also noted that the time spent by the healthcare workers in documenting the healthcare services. Harris et al. (2018) reported that health informatics helps to reduce burnout and occupational stress among nurses by reducing the time they spend in making the manual data entry. In this design, these healthcare workers would experience a reduced burden of burnout and the result would be positive impact on patients' care practices. At the same time, using the electronic order entry approaches significantly helped to meet the standardized communication, which also has numerous benefits, including reduction in the medication errors. A case study by Rasmi et al. (2018) in Jordan also noted a positive association between the use of electronic health records and many features of the health workers including, hedonic expectancy, competency, social influence and practice habit, which also have a critical niche in the healthcare workers' competencies.

#### **Impact of socio-demographic and work factors on the implication of health informatics**

This study outcome showed that only age and level of education had impact on the healthcare workers perceptions on the role of health informatics. The other factors, including gender and

department of work did not have any significant impact on the role of health informatics. Nevertheless, some previous studies have also noted the implication of socio-demographic factors on role of health informatics (Riordan et al., 2021; Schinasi et al., 2018).

It was noted that older health workers had stronger perception on the role of health informatics in enhancing the quality of patients' care in Saudi German Hospital. This relationship can be linked to the duration of experience, whereby older employees could have experienced the negative features of the analogue system and can compare with the recent digital systems. Tubaishat (2018) and Kinnunen et al. (2019) noted that professional experience influenced the healthcare workers perceived roles electronic health records. However, Tubaishat (2018), also observed that gender, professional rank and computer skills influenced the workers perceptions.

The healthcare workers with higher levels of education considered health informatics to be more effective than perceived by the younger healthcare workers and those with lower levels of education. In the same way, Kinnunen et al. (2019) reported that level of education and sufficiency of training had a positive impact on the perceived role of electronic health records. The relationship can be gauged from the idea that education and training improve the employees' knowledge on handling the electronic health records and hence the ease of use and positive regards.

### **Limitation**

Two limitations should be noted. The first limitation is the use participants from a single hospital center. Even though the sample gave an adequate representation of the research population, the outcomes would have been slightly different if other research centers were included since different organizations have different cultures, and other difference regarding the use of healthcare information technology. The second limitation was the use of quantitative methods only. The study would have benefited more by using mixed methodology so as to establish the reasons behind the differences in the use of health informatics.

### **Conclusion**

This study examined the implication of health informatics on the healthcare workers' practices in Saudi German Hospital, Jeddah in Saudi Arabia. The study become necessary to avail the most recent outcomes regarding the use of health informatics on three main areas that have not been fully explored in Saudi Arabia. The quantitative cross-sectional research design was applied. From the observed outcomes and discussions based on the literature evidence, it can be noted that health informatics plays significant roles in many aspects, notably in healthcare service delivery, information quality, quality of patient care, health workers competencies and patient safety. However, the perceived role of health informatics depends on the healthcare workers' level of education and age, which can be linked to experience and knowledge on information system.

## References

- Abaidoo, B., & Larweh, B. T. (2014). Consumer health informatics: the application of ICT in improving patient-provider partnership for a better health care. *Online journal of public health informatics*, 6(2). Accessed from <https://doi.org/10.5210/ojphi.v6i2.4903>
- Agrawal, A. (2009). Medication errors: prevention using information technology systems. *British journal of clinical pharmacology*, 67(6), 681–686. <https://doi.org/10.1111/j.1365-2125.2009.03427.x>
- Ajami, S., & Bagheri-Tadi, T. (2013). Barriers for Adopting Electronic Health Records (EHRs) by Physicians. *Acta informatica medica : AIM : journal of the Society for Medical Informatics of Bosnia & Herzegovina : casopis Drustva za medicinsku informatiku BiH*, 21(2), 129–134. <https://doi.org/10.5455/aim.2013.21.129-134>
- Alex, S., Adenew, A. B., Arundel, C., Maron, D. D., & Kerns, J. C. (2016). Medication Errors Despite Using Electronic Health Records: The Value of a Clinical Pharmacist Service in Reducing Discharge-Related Medication Errors. *Quality management in health care*, 25(1), 32–37. <https://doi.org/10.1097/QMH.000000000000080>
- Alghamdi, S. M., Alqahtani, J. S., & Aldhahir, A. M. (2020). Current status of telehealth in Saudi Arabia during COVID-19. *Journal of family & community medicine*, 27(3), 208. [https://doi.org/10.4103/jfcm.JFCM\\_295\\_20](https://doi.org/10.4103/jfcm.JFCM_295_20)



- Alghamdi, S. M., Alsulayyim, A. S., Alqahtani, J. S., & Aldhahir, A. M. (2021, November). Digital Health platforms in Saudi Arabia: Determinants from the COVID-19 pandemic experience. In *Healthcare* (Vol. 9, No. 11, p. 1517). MDPI. <https://doi.org/10.3390/healthcare9111517>
- AlSadrah S. A. (2020). Electronic medical records and health care promotion in Saudi Arabia. *Saudi medical journal*, 41(6), 583–589. <https://doi.org/10.15537/smj.2020.6.25115>
- Alsharo, M., Alnsour, Y., & Alabdallah, M. (2020). How habit affects continuous use: evidence from Jordan’s national health information system. *Informatics for Health and Social Care*, 45(1), 43-56. <https://doi.org/10.1080/17538157.2018.1540423>
- Ammenwerth, E., Schnell-Inderst, P., & Hoerbst, A. (2012). The impact of electronic patient portals on patient care: a systematic review of controlled trials. *Journal of medical Internet research*, 14(6), e162. <https://doi.org/10.2196/jmir.2238>
- Atasoy, H., Greenwood, B. N., & McCullough, J. S. (2019). The Digitization of Patient Care: A Review of the Effects of Electronic Health Records on Health Care Quality and Utilization. *Annual review of public health*, 40, 487–500. <https://doi.org/10.1146/annurev-publhealth-040218-04420>
- Bae, J., & Encinosa, W. E. (2016). National estimates of the impact of electronic health records on the workload of primary care physicians. *BMC health services research*, 16(1), 172.
- Bowman, S. (2013). Impact of electronic health record systems on information integrity: quality and safety implications. *Perspectives in health information management*, 10(Fall).
- Castaneda, C., Nalley, K., Mannion, C., Bhattacharyya, P., Blake, P., Pecora, A., ... & Suh, K. S. (2015). Clinical decision support systems for improving diagnostic accuracy and achieving precision medicine. *Journal of clinical bioinformatics*, 5(1), 1-16.
- Cesnik, B., & Kidd, M. R. (2010). History of health informatics: a global perspective. *Studies in health technology and informatics*, 151, 3–8.
- Chakraborty, I., Ilavarasan, P. V., & Edirippulige, S. (2021). Health-tech startups in healthcare service delivery: A scoping review. *Social science & medicine* (1982), 278, 113949. <https://doi.org/10.1016/j.socscimed.2021.113949>
- Curtis, J. R., Sathitratancheewin, S., Starks, H., Lee, R. Y., Kross, E. K., Downey, L., Sibley, J., Lober, W., Loggers, E. T., Fausto, J. A., Lindvall, C., & Engelberg, R. A. (2018). Using Electronic Health Records for Quality Measurement and Accountability in Care of

- the Seriously Ill: Opportunities and Challenges. *Journal of palliative medicine*, 21(S2), S52–S60.  
<https://doi.org/10.1089/jpm.2017.0542>
- Dubovitskaya, A., Xu, Z., Ryu, S., Schumacher, M., & Wang, F. (2017). Secure and trustable electronic medical records sharing using blockchain. In *AMIA annual symposium proceedings* (Vol. 2017, p. 650). American Medical Informatics Association.
- El Mahalli A. (2015). Adoption and Barriers to Adoption of Electronic Health Records by Nurses in Three Governmental Hospitals in Eastern Province, Saudi Arabia. *Perspectives in health information management*, 12(Fall), 1f.
- Feldman, S. S., Buchalter, S., & Hayes, L. W. (2018). Health information technology in healthcare quality and patient safety: literature review. *JMIR medical informatics*, 6(2), e10264.  
<https://doi.org/10.2196/10264>
- Fernández-Alemán, J. L., Señor, I. C., Lozoya, P. Á. O., & Toval, A. (2013). Security and privacy in electronic health records: A systematic literature review. *Journal of biomedical informatics*, 46(3), 541-562.
- Forrest, G. N., Van Schooneveld, T. C., Kullar, R., Schulz, L. T., Duong, P., & Postelnick, M. (2014). Use of electronic health records and clinical decision support systems for antimicrobial stewardship. *Clinical Infectious Diseases*, 59(suppl\_3), S122-S133.
- Goldstein, B. A., Navar, A. M., Pencina, M. J., & Ioannidis, J. (2017). Opportunities and challenges in developing risk prediction models with electronic health records data: a systematic review. *Journal of the American Medical Informatics Association*, 24(1), 198-208.
- Han, J. E., Rabinovich, M., Abraham, P., Satyanarayana, P., Liao, T. V., Udoji, T. N., ... & Martin, G. S. (2016). Effect of electronic health record implementation in critical care on survival and medication errors. *The American journal of the medical sciences*, 351(6), 576-581.
- Harris, D. A., Haskell, J., Cooper, E., Crouse, N., & Gardner, R. (2018). Estimating the association between burnout and electronic health record-related stress among advanced practice registered nurses. *Applied Nursing Research*, 43, 36-41.
- Hassounah, M., Raheel, H., & Alhefzi, M. (2020). Digital response during the COVID-19 pandemic in Saudi Arabia. *Journal of medical Internet research*, 22(9), e19338.  
<https://doi.org/10.2196/19338>
- Herrin, J., da Graca, B., Nicewander, D., Fullerton, C., Aponte, P., Stanek, G., ... & Ballard, D. J. (2012). The effectiveness of implementing

- an electronic health record on diabetes care and outcomes. *Health services research*, 47(4), 1522-1540.
- Hess, E., Palmer, S. E., Stivers, A., & Amerine, L. B. (2020). Impact of an electronic health record transition on chemotherapy error reporting. *Journal of oncology pharmacy practice : official publication of the International Society of Oncology Pharmacy Practitioners*, 26(4), 787–793.  
<https://doi.org/10.1177/1078155219870590>
- Hripcsak, G., & Albers, D. J. (2013). Next-generation phenotyping of electronic health records. *Journal of the American Medical Informatics Association*, 20(1), 117-121.
- Iqbal, U., Syed-Abdul, Y., & Yu-Chuan (Jack) Li (2015). Health information technology and team work to improve health care. *International Journal for Quality in Health Care*, 27(6), 423, <https://doi.org/10.1093/intqhc/mzv087>
- Jensen, P. B., Jensen, L. J., & Brunak, S. (2012). Mining electronic health records: towards better research applications and clinical care. *Nature Reviews Genetics*, 13(6), 395-405.
- Jindal, S. K., & Raziuddin, F. (2018). Electronic medical record use and perceived medical error reduction. *International Journal of Quality and Service Sciences*, 10(1), 84-95.  
<https://doi.org/10.1108/IJQSS-12-2016-0081>
- Khalifa, M. (2013). Barriers to health information systems and electronic medical records implementation. A field study of Saudi Arabian hospitals. *Procedia Computer Science*, 21, 335-342.
- Kharrazi, H., Ma, X., Chang, H. Y., Richards, T. M., & Jung, C. (2021). Comparing the predictive effects of patient medication adherence indices in electronic health record and claims-based risk stratification models. *Population health management*, 24(5), 601-609.
- Kinnunen, U. M., Heponiemi, T., Rajalahti, E., Ahonen, O., Korhonen, T., & Hyppönen, H. (2019). factors related to health informatics competencies for nurses—results of a national electronic health record survey. *CIN: Computers, Informatics, Nursing*, 37(8), 420-429.
- Kruse, C. S., Mileski, M., Vijaykumar, A. G., Viswanathan, S. V., Suskandla, U., & Chidambaram, Y. (2017). Impact of Electronic Health Records on Long-Term Care Facilities: Systematic Review. *JMIR medical informatics*, 5(3), e35.  
<https://doi.org/10.2196/medinform.7958>
- Kruse, C. S., Smith, B., Vanderlinden, H., & Nealand, A. (2017). Security techniques for the electronic health records. *Journal of medical systems*, 41(8), 1-9.

- Li, D., & Korniewicz, D. M. (2013). Determination of the Effectiveness of Electronic Health Records To Document Pressure Ulcers. *Medsurg Nursing*, 22(1).
- Mahajan, V., Singh, T., & Azad, C. (2020). Using Telemedicine During the COVID-19 Pandemic. *Indian pediatrics*, 57(7), 652–657.
- Meri, A., Hasan, M. K., Danaee, M., Jaber, M., Safei, N., Dauwed, M., ... & Al-bsheish, M. (2019). Modelling the utilization of cloud health information systems in the Iraqi public healthcare sector. *Telematics and Informatics*, 36, 132-146.  
<https://doi.org/10.1016/j.tele.2018.12.001>
- Meropol N. J. (2018). Opportunities for using big data to advance cancer care. *Clinical advances in hematology & oncology : H&O*, 16(12), 807–809.
- Middleton, B., Bloomrosen, M., Dente, M. A., Hashmat, B., Koppel, R., Overhage, J. M., Payne, T. H., Rosenbloom, S. T., Weaver, C., Zhang, J., & American Medical Informatics Association (2013). Enhancing patient safety and quality of care by improving the usability of electronic health record systems: recommendations from AMIA. *Journal of the American Medical Informatics Association: JAMIA*, 20(e1), e2–e8.  
<https://doi.org/10.1136/amiainl-2012-001458>
- Moja, L., Kwag, K. H., Lytras, T., Bertizzolo, L., Brandt, L., Pecoraro, V., Rigon, G., Vaona, A., Ruggiero, F., Mangia, M., Iorio, A., Kunnamo, I., & Bonovas, S. (2014). Effectiveness of computerized decision support systems linked to electronic health records: a systematic review and meta-analysis. *American journal of public health*, 104(12), e12–e22.  
<https://doi.org/10.2105/AJPH.2014.302164>
- Moy, A. J., Schwartz, J. M., Chen, R., Sadri, S., Lucas, E., Cato, K. D., & Rossetti, S. C. (2021). Measurement of clinical documentation burden among physicians and nurses using electronic health records: a scoping review. *Journal of the American Medical Informatics Association*, 28(5), 998-1008.
- Musen, M. A., Middleton, B., & Greenes, R. A. (2021). Clinical decision-support systems. In *Biomedical informatics* (pp. 795-840). Springer, Cham.
- Mutshatshi, T. E., Mothiba, T. M., Mamogobo, P. M., & Mbombi, M. O. (2018). Record-keeping: Challenges experienced by nurses in selected public hospitals. *Curationis*, 41(1), 1-6.
- Neves, A. L., Carter, A. W., Freise, L., Laranjo, L., Darzi, A., & Mayer, E. K. (2018). Impact of sharing electronic health records with patients on the quality and safety of care: a systematic review and narrative synthesis protocol. *BMJ open*, 8(8), e2020387.

- Neves, A. L., Carter, A. W., Freise, L., Laranjo, L., Darzi, A., & Mayer, E. K. (2018). Impact of sharing electronic health records with patients on the quality and safety of care: a systematic review and narrative synthesis protocol. *BMJ open*, 8(8), e020387. <https://doi.org/10.1136/bmjopen-2017-020387>
- Nguyen, P. A., Wang, Y. C., & Jack Li, Y. C. (2018). The role of informatics in improving patient care. *Computer methods and programs in biomedicine*, 163, A1. <https://doi.org/10.1016/j.cmpb.2018.08.001>
- Nijhawan, L. P., Janodia, M. D., Muddukrishna, B. S., Bhat, K. M., Bairy, K. L., Udupa, N., & Musmade, P. B. (2013). Informed consent: Issues and challenges. *Journal of advanced pharmaceutical technology & research*, 4(3), 134.
- Oluwatayo, J. A. (2012). Validity and reliability issues in educational research. *Journal of Educational and Social Research*, 2(2), 391-400.
- Othman, M., & Hayajneh, J. A. (2015). An integrated success model for an electronic health record: a case study of Hakeem Jordan. *Procedia economics and finance*, 23, 95-103.
- Persell, S., Kaiser, M., Dolan, N., Andrews, B., Levi, S., Kahndekar, J., Baker, D. (2011). Changes in performance after implementation of a multifaceted electronic-healthrecord-based quality improvement system. *Medical Care*, 49 (2), 117-125.
- Pettit, N. N., Han, Z., Choksi, A., Voas-Marszowski, D., & Pisano, J. (2019). Reducing medication errors involving antiretroviral therapy with targeted electronic medical record modifications. *AIDS care*, 31(7), 893–896. <https://doi.org/10.1080/09540121.2019.1566512>
- Rahimi, B., Nadri, H., Afshar, H. L., & Timpka, T. (2018). A systematic review of the technology acceptance model in health informatics. *Applied clinical informatics*, 9(03), 604-634. DOI: 10.1055/s-0038-1668091
- Rasmi, M., Alazzam, M. B., Alsmadi, M. K., Almarashdeh, I. A., Alkhasawneh, R. A., & Alsmadi, S. (2018). Healthcare professionals' acceptance Electronic Health Records system: Critical literature review (Jordan case study). *International Journal of Healthcare Management*.
- Ratwani, R. M., Savage, E., Will, A., Fong, A., Karavite, D., Muthu, N., Rivera, A. J., Gibson, C., Asmonga, D., Moscovitch, B., Grundmeier, R., & Rising, J. (2018). Identifying Electronic Health Record Usability And Safety Challenges In Pediatric Settings. *Health affairs (Project Hope)*, 37(11), 1752–1759. <https://doi.org/10.1377/hlthaff.2018.0699>

- Reid, L., Maeder, A., Button, D., Breaden, K., & Brommeyer, M. (2021). Defining Nursing Informatics: A Narrative Review. *Studies in health technology and informatics*, 284, 108–112.  
<https://doi.org/10.3233/SHTI210680>
- Riordan, F., Papoutsi, C., Reed, J. E., Marston, C., Bell, D., & Majeed, A. (2015). Patient and public attitudes towards informed consent models and levels of awareness of Electronic Health Records in the UK. *International journal of medical informatics*, 84(4), 237–247. <https://doi.org/10.1016/j.ijmedinf.2015.01.008>
- Rothman, B., Leonard, J. C., & Vigoda, M. M. (2012). Future of electronic health records: implications for decision support. *The Mount Sinai journal of medicine, New York*, 79(6), 757–768.  
<https://doi.org/10.1002/msj.21351>
- Rouleau, G., Gagnon, M. P., & Côté, J. (2015). Impacts of information and communication technologies on nursing care: an overview of systematic reviews (protocol). *Systematic reviews*, 4(1), 75.
- Rozenblum, R., Donzé, J., Hockey, P. M., Guzdar, E., Labuzetta, M. A., Zimlichman, E., & Bates, D. W. (2013). The impact of medical informatics on patient satisfaction: a USA-based literature review. *International journal of medical informatics*, 82(3), 141–158. <https://doi.org/10.1016/j.ijmedinf.2012.12.008>
- Sadoughi, F., Nasiri, S., & Ahmadi, H. (2018). The impact of health information exchange on healthcare quality and cost-effectiveness: A systematic literature review. *Computer methods and programs in biomedicine*, 161, 209–232.  
<https://doi.org/10.1016/j.cmpb.2018.04.023>
- Salmond, S. W., & Echevarria, M. (2017). Healthcare Transformation and Changing Roles for Nursing. *Orthopedic nursing*, 36(1), 12–25.  
<https://doi.org/10.1097/NOR.0000000000000308>
- Sayed, M. E. (2021). Knowledge, attitude and behaviour of dental health care providers towards health electronic record systems in Saudi Arabia. *Health information and libraries journal*, 38(3), 194–202.  
<https://doi.org/10.1111/hir.12290>
- Schinasi, L. H., Auchincloss, A. H., Forrest, C. B., & Roux, A. V. D. (2018). Using electronic health record data for environmental and place based population health research: a systematic review. *Annals of epidemiology*, 28(7), 493-502.
- Schoener, B., Baird, P., Dorn, L., Giuliano, K. K., Ho, M., Jump, M., Sahiner, B., & Zink, R. (2018). Using Data-Based Decisions to Transform Health Technology and Improve Patient Care. *Biomedical instrumentation & technology*, 52(s2), 7–16.  
<https://doi.org/10.2345/0899-8205-52.s2.7>
- Sensmeier, J., & Anderson, C. (2021). Tracking the impact of nursing informatics. *Nursing made Incredibly Easy*, 19(1), 49-53.

- Siedlecki, S., & Hixson, E. (2015). Relationships between nurses and physicians matter. *The Online Journal of Issues in Nursing*, 20(3).
- Silow-Carroll, S., Edwards, J. N., & Rodin, D. (2012). Using electronic health records to improve quality and efficiency: the experiences of leading hospitals. *Issue Brief (Commonw Fund)*, 17(1), 40.
- Singh, K., Johnson, L., Devarajan, R., Shivashankar, R., Sharma, P., Kondal, D., Ajay, V. S., Narayan, K., Prabhakaran, D., Ali, M. K., & Tandon, N. (2018). Acceptability of a decision-support electronic health record system and its impact on diabetes care goals in South Asia: a mixed-methods evaluation of the CARRS trial. *Diabetic medicine : a journal of the British Diabetic Association*, 35(12), 1644–1654. <https://doi.org/10.1111/dme.13804>
- Snyder, C. F., Wu, A. W., Miller, R. S., Jensen, R. E., Bantug, E. T., & Wolff, A. C. (2011). The role of informatics in promoting patient-centered care. *Cancer journal (Sudbury, Mass.)*, 17(4), 211–218. <https://doi.org/10.1097/PPO.0b013e318225ff89>
- Tai-Seale, M., Olson, C. W., Li, J., Chan, A. S., Morikawa, C., Durbin, M., Wang, W., & Luft, H. S. (2017). Electronic Health Record Logs Indicate That Physicians Split Time Evenly Between Seeing Patients And Desktop Medicine. *Health affairs (Project Hope)*, 36(4), 655–662. <https://doi.org/10.1377/hlthaff.2016.0811>
- Tanwar, S., Parekh, K., & Evans, R. (2020). Blockchain-based electronic healthcare record system for healthcare 4.0 applications. *Journal of Information Security and Applications*, 50, 102407. <https://doi.org/10.1016/j.jisa.2019.102407>
- Tubaishat A. (2018). Perceived usefulness and perceived ease of use of electronic health records among nurses: Application of Technology Acceptance Model. *Informatics for health & social care*, 43(4), 379–389. <https://doi.org/10.1080/17538157.2017.1363761>
- Vaidotas, M., Yokota, P., Negrini, N., Leiderman, D., Souza, V. P., Santos, O., & Wolosker, N. (2019). Medication errors in emergency departments: is electronic medical record an effective barrier?. *Einstein (Sao Paulo, Brazil)*, 17(4), eGS4282. [https://doi.org/10.31744/einstein\\_journal/2019GS4282](https://doi.org/10.31744/einstein_journal/2019GS4282)
- van der Vaart, R., Drossaert, C. H., Taal, E., Drossaers-Bakker, K. W., Vonkeman, H. E., & van de Laar, M. A. (2014). Impact of patient-accessible electronic medical records in rheumatology: use, satisfaction and effects on empowerment among patients. *BMC musculoskeletal disorders*, 15, 102. <https://doi.org/10.1186/1471-2474-15-102>

Special Issue On Multidisciplinary Research

Zahabi, M., Kaber, D. B., & Swangnetr, M. (2015). Usability and Safety in Electronic Medical Records Interface Design: A Review of Recent Literature and Guideline Formulation. *Human factors*, 57(5), 805–834. <https://doi.org/10.1177/0018720815576827>