Research Article
Volume 15:01, 2024

Journal of Health & Medical Informatics

ISSN: 2157-7420

Open Access

How has the Implementation of the Electronic Health Records (EHRs) Affected the Medication Dispensing Time in the in-patient Pharmacy Department at Buraydah Central Hospital, Kingdom of Saudi Arabia? A Quasi-Experimental Study

Turki Hamoud Alanazi*

Department of Health Informatics, Swansea University, Swansea, Wales, UK

Abstract

Background: Electronic Health Records (EHRs) are increasingly adopted worldwide, but evidence of their effects on medication dispensing efficiency is limited, particularly in non-Western healthcare settings. The aim of this study was to evaluate the impact of an EHR system on medication dispensing time in a hospital pharmacy in Saudi Arabia.

Methods: A quasi-experimental pre-post study design was used to compare medication dispensing times before and after EHR implementation across seven inpatient departments in Buraydah Central Hospital. Timestamp data on 5,110 medication dispensing instances were extracted from the pharmacy records.

Results: EHR implementation led to statistically significant reductions in overall mean dispensing times (by 25.8%, from 90.9 minutes to 67.5 minutes, p<0.001) and within each department (by 16.3% – 49.1%, p<0.001).

Conclusion: This study provides quantitative evidence that introducing the use of EHRs substantially improved the medication dispensing efficiency in a Saudi Arabian hospital pharmacy. Further research should assess the long-term impacts of the use of EHRs across multiple sites.

Keywords: Electronic health record • Medication dispensing • Pharmacy • Time efficiency • Saudi Arabia

Introduction

Background

The healthcare industry has undergone significant change due to the implementation of digital technologies including Electronic Health Records (EHRs) [1,2]. EHRs comprise digital versions of patients' medical information and clinical workflows, allowing to manage data more effectively through storage, access, and sharing capabilities [3,4]. However, while EHR implementation holds opportunities to enhance the quality of care, patient safety, and operational efficiency, realising these benefits depends greatly on the design, training, and optimisation of the EHR system [5].

Pharmacy operations are among the areas most affected by the implementation of EHRs [6]. Medication dispensing is a complicated procedure with several phases, including prescribing, transcribing, dispensing, administration, and monitoring; any delay in these phases might have serious consequences for patient care [7,8]. EHRs can facilitate Computerised Provider Order Entry, (CPOE) barcode-assisted dispensing, robust medication reconciliation, and enhanced decision support [8-10]. Nevertheless, poor system design and suboptimal user interfaces may introduce inefficiencies or new errors [11,12].

***Address for Correspondence:** Turki Hamoud Alanazi, Department of Health Informatics, Swansea University, Swansea, Wales, UK, Tel: 0569662111, E-mail: rx.turki@gmail.com*

Received: 02 January, 2024, Manuscript No. jhmi-24-125385; **Editor Assigned:** 04 January, 2024, PreQC No. P-125385; **Reviewed:** 16 January, 2024, QC No. Q-125385; **Revised:** 22 January, 2024, Manuscript No. R-125385; **Published:** 30 January, 2024, DOI: 10.37421/2157-7420.2024.15.507

Achieving optimal medication dispensing is of the utmost importance for enhancing patient safety, influencing healthcare expenditures, and efficient resource allocation [13]. Understanding the real-world impacts of EHR adoption on healthcare delivery time is essential [14,15]. However, despite the broad implementation of EHRs, only minimal empirical information is available on their influence on drug dispensing time, particularly in specific settings such as inpatient hospital pharmacies [16,17]. This knowledge gap in the existing literature emphasises the need for targeted research to fully understand the real-world consequences of EHR implementation for this mission-critical pharmacy workflow. The aim of this research was to address these gaps by analysing EHR impacts on medication dispensing times across multiple inpatient departments in a Saudi Arabian hospital.

Research aims, objective, rational and hypothesis

Aims: This study aimed to investigate and quantify the effect of implementing an EHR system on medication dispensing times in the inpatient pharmacy department of Buraydah Central Hospital (BCH) in Saudi Arabia.

Objectives: The study has two primary objectives:

- To compare the mean medication dispensing times before and after implementation of the EHR system across selected inpatient departments.
- To evaluate the effect of the EHR system on medication dispensing times within each individual selected department separately.

Rationale: While EHR adoption has been widely studied within various healthcare contexts, a dearth of comprehensive reviews have focused specifically on the impact of EHRs in the inpatient pharmacy department, particularly concerning medication dispensing time [18-21]. This is a significant gap in the literature, given that the time and accuracy of medication dispensing are directly correlated with patient outcomes [22,23].

Moreover, the context of BCH, a healthcare institution in a non-Western setting, adds another layer of complexity. Many EHR studies are rooted in Western healthcare models, but different healthcare settings have unique challenges and opportunities [24-26]. Understanding the impact of EHRs on medication dispensing in such a distinct environment could not only contribute to localised improvements but also add to the global discourse on healthcare optimisation. Furthermore, as Saudi Arabia rapidly boosts nationwide EHR adoption under its Vision 2030 plan, insights from hospitals in this non-Western context can guide successful implementations [27].

Hypotheses: Based on the study's objectives, hypotheses were formulated.

- **For the first objective:**

Null hypothesis (H01): The mean medication dispensing times do not significantly differ between before and after the implementation of EHRs across all the hospital departments selected.

Alternative hypothesis (Ha1): Mean medication dispensing times are lower after than before the EHR implementation across all the hospital departments selected.

- **For the second objective:**

Null hypothesis (H02): The mean medication dispensing times do not significantly differ before and after EHR implementation within each hospital department selected.

Alternative hypothesis (Ha2): Mean medication dispensing times are lower after than before EHR implementation in each hospital department selected. (Appendix 1)

Research questions

A. What was the mean medication dispensing time at BCH's inpatient pharmacy department before the introduction of the EHR?

B. What was the mean medication dispensing time after the EHR had been implemented in the same setting?

C. Was there a statistically significant difference between the mean medication dispensing times before and after EHR implementation across all the selected inpatient departments?

By addressing these questions, this research was aimed at providing substantial perspectives on the efficiency of EHRs in augmenting pharmacy operations and thereby contribute to the broader discourse on the digitisation of healthcare and answering the main question, 'How has the EHR implementation affected the medication dispensing time in the inpatient pharmacy department at BCH?'

Literature Review

EHRs have been swiftly integrated into healthcare systems with the aim of enhancing care quality, bolstering patient safety, and optimising operational effectiveness [28]. This influenced the critical area of medication management, which remains complex across prescribing, dispensing, administration, and monitoring [29].

The correlation between the utilisation of electronic pharmacy technology and the developments in pharmaceutical services is evident, enabling a more efficient and secure distribution of medications [30]. Several studies have underscored the advantages of employing EHRs, such as the amplification of operational efficiency, elevation of patient safety benchmarks, and reduction of medication-associated errors [31,32]. The implementation of electronic prescribing systems in hospitals has been shown to reduce medication errors and adverse drug reactions while improving the overall quality and efficiency of pharmacy services [33]. However, previous research on the broad effects of EHRs has shown mixed results in terms of their impact on efficiency. While some studies have found that EHRs can reduce documentation time and errors [34,35]. Others have revealed potential drawbacks such as increased workload for clinicians [36,37].

When examining medication dispensing, some studies have shown that EHR incorporation lowered turnaround times and transcription errors for medication orders, enabling faster dispensing [38]. Multiple pre-post studies have found that order turnaround times, including dispensing phases, were shorter after adopting EHRs with Computerised Physician Order Entry (CPOE) instead of paper workflows [39,40]. Mekhjian HS, et al. found that after implementing CPOE, the mean pharmacy dispensing time decreased by 70%, from 115 minutes to 35 minutes [39]. Similarly, Franklin BD, et al. found that an electronic prescribing system led to a 13.5% decline in mean dispensing time, from 122 minutes to 105 minutes [40].

However, integrating technological solutions into pharmaceutical services such as electronic prescribing through EHR can disrupt the conventional workflow in pharmacies and jeopardise the overall quality of services [41]. According to previous studies, the workflow disruptions by e-prescribing systems stem from several factors [42-44]. Poor system usability and complex interfaces cause complications for users, slowing down dispensing procedures [42]. Another factor is technical challenges such as system unavailability, which might lead to interruptions in pharmacy operations and delays [43]. The communication barriers between prescribers and pharmacists due to insufficient clinical details in e-prescriptions also obstructed timely dispensation [44]. Moreover, while e-prescriptions enhanced legibility and accessibility, these increased pharmacists' workloads substantially owing to the additional documentation demands [45]. In a time-motion study, Hollingworth W, et al. showed that e-prescribing added significant time requirements for pharmacy staff [46]. Similarly, Koppel R, et al. found that correcting and clarifying e-prescriptions caused pharmacists to expend considerable effort [47]. The ease of electronic prescribing contributed to the increasing prescription volumes, further escalating pharmacists' workloads and medication delivery times [45]. Therefore, judging the efficacy of such technological systems should not be based on blind faith, unless their actual impacts on health services have been thoroughly examined.

The introduction of the EHR system in Saudi Arabia has exerted a considerable influence on the country's healthcare structure, including laboratory and radiology services [48]. However, pharmacy services in Saudi Arabia are understudied and face challenges. Al-Hanawi MK and Makuta IF discussed the necessity of monitoring, evaluating, and enhancing performance in healthcare services in Saudi Arabia [49]. This suggests room for improvement in the efficiency and effectiveness of pharmacy services. Thus, the intent of this study was to comprehend the influence of the EHR on the efficacy of dispensing services, consequently facilitating the enhancement of healthcare provision in the Kingdom.

Methodology

Study design

A quasi-experimental design using a before-and-after study method would be most effective to address the research question. Quasi-experimental approaches are commonly employed in implementation studies to evaluate the effectiveness of interventions in real-world contexts [50]. They are commonly employed in health service research and have promise for generating dependable findings when conducting randomised controlled trials is unfeasible or unethical [51]. Given the comprehensive integration of the EHR system across the whole BCH, designing a control group that is not exposed to the intervention would be impractical.

Quasi-experimental research is cost-effective and time efficient, as it permits the utilisation of pre-existing data [52,53]. It allows researchers to utilise existing data, reducing the need for costly data collection efforts, and resulting in a more efficient and cost-effective implementation procedure [52,53]. In addition, quasi-experimental designs are frequently employed in settings where the intervention has already been applied [54]. Hence, the current adoption of EHR in BCH necessitates using a quasi-experimental design to effectively measure the effect of this implementation on the time required for medication dispensing.

Population and sampling

The target population for this study comprised the inpatient medication dispensing workflows at BCH in Saudi Arabia. Specifically, the dispensing times for medication trollies were investigated across seven inpatient departments: the Male Medical Ward (MMW), Female Medical Ward (FMW), Male Surgical Ward (MSW), Female Surgical Ward (FSW), Male Orthopaedic Ward (MOW), Female Orthopaedic Ward (FOW), and Intensive Care Unit (ICU). These departments were chosen to cover a different range of hospital operations and patient populations.

A convenience sampling method was used. This strategy is distinguished by the selection of subjects based on their instant accessibility and geographical proximity to the researcher [55]. One notable characteristic of this methodology is its cost-effectiveness, as it often requires fewer resources than other more rigorous sampling techniques, making it a financially wise choice [56,57]. Within the framework of this research, which was conducted under limited financial resources, the cost-effectiveness of convenience sampling was of remarkable importance.

In addition, convenience sampling offers time efficiency in collecting data, which might be attributed to the availability of pertinent data [55]. The approach chosen is often more efficient than other sampling procedures in terms of time, mainly because it eliminates the requirement for extensive population lists or the use of complex participant selection algorithms [58]. As this study was conducted within a limited time frame, the relevance of convenience sampling is particularly noteworthy and offered a prompt and efficient means of acquiring data.

Sample size

The sample included dispensing times for each selected department over 365 days before EHR implementation (1 January to 31 December 2019) and 365 days after implementation (1 January to 31 December 2022). This resulted in a total sample of 5,110 timepoint measurements (365 per department $\times$ 7 departments $\times$ 2 years).

Data collection

This study used existing secondary data that were initially collected by the pharmacy department at BCH for operational purposes. Secondary data refers to data obtained by another individual or for a different research purpose before the current investigation [59]. Secondary data collection offers advantages, including efficiency, cost-effectiveness, and access to data without inconveniencing patients [60-63]. Considering that these timepoint records are an essential element of the pharmacy's regular operations, it is anticipated that the data will possess both accuracy and reliability [64].

The pharmacy department at BCH utilised paper forms for data collection even after the implementation of the EHR. They formerly used paper forms to record the time at which the nurse transported the medication trolley to the pharmacy and when the pharmacist completed the dispensation of the trolley. Building on this, Excel worksheets were produced to display the time disparity between the two time points. Excel was chosen given its widespread availability and usability for data management [65].

The spreadsheet compiled medication dispensing times for the selected departments over two intervals:

- 1 January to 31 December 2019, representing the 12 months before EHR implementation. (Appendix 2)
- 1 January to 31 December 2022, representing the 12 months after EHR implementation. (Appendix 3)

The 2020 and 2021 time frames were purposefully omitted to avoid confounding the COVID-19 (coronavirus disease) pandemic as much as possible.

Research setting

The research was conducted at BCH in the Al-Qassim area of Saudi Arabia. The focus of the study was particularly on the inpatient pharmacy unit inside the pharmaceutical care department of the hospital, as it housed all the data required for the study.

BCH is a tertiary care hospital with a capacity of 400 beds that offers specialised medical and surgical services across many disciplines. On a daily basis, the hospital admits an average of 23 to 25 patients. The hospital has received accreditation from the Saudi Central Board for Accreditation of Healthcare Institutions, indicating its adherence to quality standards for patient care and safety. In January 2020, BCH implemented a comprehensive EHR system to modernise clinical documentation, order management, decision support, and data analytics capabilities hospital-wide.

Inclusion and exclusion criteria

Inclusion criteria:

- The study included seven inpatient departments that admitted adult patients: the MMW, FMW, MSW, FSW, MOW, FOW, and ICU.

Exclusion criteria:

- The study omitted any departments that were not explicitly included.
- The period from January 2020 to December 2021 was purposefully omitted to mitigate the consequences of the COVID-19 pandemic in the study.

Research governance

Collecting secondary data requires no direct engagement or interaction with patients, consequently mitigating any potential disruptions or inconveniences [60]. Moreover, patient confidentiality was rigorously maintained, and the use of pre-existing data for achieving the research objectives was deemed ethically justifiable [66]. Therefore, the necessary ethical approvals were received by the relevant entities, namely Swansea University (approval No. 2 2023 7021 6223, Appendix 4) and BCH (Appendix 5).

Data analysis strategy and hypotheses tests

The data analysis was performed utilising the Statistical Package for the Social Sciences (SPSS) version 29.0.1.0 (171). SPSS offers a comprehensive set of data management capabilities that enable smooth data importation from diverse sources such as databases and spreadsheets and the integration of data from numerous files, resulting in a more comprehensive collection of data that allow for the specification of additional information to ensure the accuracy and simplicity of the interpretation of the studies and results [67].

First, descriptive statistics were calculated, including measures of central tendency (mean and median) and dispersion (standard deviation, minimum, and maximum), for the overall medication dispensing times before and after EHR implementation and within each department. Second, normality testing was performed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The data distribution was evaluated for statistical normality to inform the choice between parametric and non-parametric inferential tests [68]. Finally, the Wilcoxon signed-rank test was applied to assess significant differences in dispensing time and to test the hypotheses, given the non-normal data distribution [69,70].

Results and Main Findings

The results and main findings are presented in accordance with the study objectives.

Objective 1: To compare the overall mean medication dispensing times before and after implementation of the EHR system across the selected inpatient departments.

Descriptive analysis

Table 1 and Table 2 show the descriptive statistics for medication dispensing times before and after EHR implementation. Overall, before EHR implementation, the mean dispensing time was 90.92 minutes (SD=6.95, median=91.0, range=73 – 110 minutes). After implementation, the mean

Table 1. Descriptive analysis for pre-installation period (2019).

			Statistic	Std. Error
Before (2019)	Mean		90.92	.365
	95% Confidence Interval for Mean	Lower Bound	90.21	-
		Upper Bound	91.64	-
	5% Trimmed Mean		90.93	-
	Median		91.00	-
	Variance		48.348	-
	Std. Deviation		6.953	-
	Minimum		73	-
	Maximum		110	-
	Range		37	-
	Interquartile Range		10	-
	Skewness		-.002	.128
	Kurtosis		-.280	.255

Table 2. Descriptive analysis for post-installation period (2022).

			Statistic	Std. Error
After (2022)	Mean		67.48	.317
	95% Confidence Interval for Mean	Lower Bound	66.85	-
		Upper Bound	68.10	-
	5% Trimmed Mean		67.48	-
	Median		67.00	-
	Variance		36.366	-
	Std. Deviation		6.030	-
	Minimum		53	-
	Maximum		86	-
	Range		33	-
	Interquartile Range		8	-
	Skewness		-.038	.128
	Kurtosis		-.153	.255

decreased to 67.48 minutes (SD=6.03, median=67.0, range=53 – 86 minutes), reflecting a 25.8% reduction of 23.44 minutes. The median declined by 24 minutes (26.4%). Figure 1 visually depicts the reductions in the mean and median dispensing times.

Hypothesis testing

Normality tests: The normality of the datasets for ‘Before (2019)’ and ‘After (2022)’ was evaluated using various descriptive statistics and normality tests Table 3. Before EHR implementation, the normality tests, including the Kolmogorov-Smirnov and Shapiro-Wilk tests, yielded statistically significant results (p=0.001 and p=0.139, respectively), suggesting a departure from normality. After EHR implementation, similar tests applied and yielded statistically significant results (p<0.001 and p=0.035, respectively), indicating a departure from normality. Hence, a non-parametric test (Wilcoxon signed-rank test) was applied owing to the observed departures from normality in both datasets.

Wilcoxon signed-rank test results: The Wilcoxon signed-rank test was performed to assess whether the medication trolley preparation time significantly differed between before and after the installation of the EHR. The results indicate a substantial difference in medication trolley preparation times between the two time points. The mean preparation time before the EHR installation (M=90.90, SD=6.940) was noticeably higher than that after the EHR installation (M=67.48, SD=6.019). Furthermore, the Wilcoxon signed-rank test statistical value was −16.514, with a p value of .000, which is highly significant (p<.001), indicating compelling evidence to reject the null hypothesis Table 4.

Objective 2: To quantify the impact of EHRs on the dispensing times in each department.

Descriptive analysis

Overall, the data show that across all the 7 wards, EHR implementation led to a notable decline in mean medication dispensing times, ranging from 16.3%

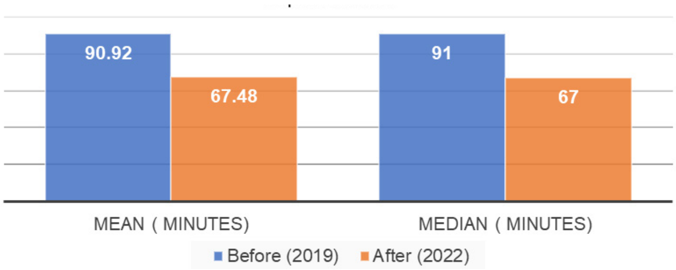

Figure 1. Mean and median medication dispensing times before and after EHR implementation.

Table 3. Tests of normality for all datasets.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Before (2019)	.066	363	.001	.994	363	.139
After (2022)	.070	363	.000	.991	363	.035

a: Lilliefors significance Correction

(MMW) to 49.1% (ICU), with the mean decreases ranging from 221.30 minutes before EHR implementation to 112.64 minutes after EHR implementation. Table 5 summarises the impact of the EHR across all departments. The percentage decreases in median times parallel the decreases in the mean values, ranging from 19.4% (MMW) to 49.1% (ICU). The ICU witnessed the greatest reduction of 72.5% (from 80 minutes to 22 minutes). The MSW had the next highest decrease of 69.8% (from 43 minutes to 13 minutes). All other departments saw reductions ranging from 10.8% (FOW) to 41% (MOW). Figure 2 depicts the percentage reductions in time after EHR implementation.

In the FMW, the mean dispensing time decreased by 23.4%, from 121.27

Table 4. Descriptive statistics, wilcoxon signed-rank test results, and hypothesis test results.

		N	Mean	Std. Deviation	Minimum	Maximum
All selected departments	Before (2019)	366	90.90	6.940	73	110
	After (2022)	365	67.48	6.019	53	86
	Z	-16 514				
	P-value	.000				
	Hypothesis test result	Reject the null hypothesis				

Table 5. Summary of the mean, median, range, and standard deviation of medication dispensing times before and after EHR implementation for each of the 7 departments.

Department	Mean Before	Mean After	% Change	Median Before	Median After	% Change	Range Before	Range After	% Change	SD Before (Min)	SD After (Min)	% Change
FMW	121.27	92.92	23.4%	122	93	23.8%	41	29	29.3%	7.96	4.88	38.7%
FOW	90.92	67.48	25.8%	91	67	26.4%	37	33	10.8%	6.94	6.02	13.3%
FSW	64.90	47.56	26.7%	66	47	28.8%	31	19	38.7%	4.63	4.51	2.6%
ICU	221.30	112.64	49.1%	222	113	49.1%	80	22	72.5%	15.42	3.27	78.8%
MMW	104.42	87.34	16.4%	108	87	19.4%	67	22	67.2%	13.70	4.59	66.5%
MOW	98.20	70.21	28.5%	96.5	70	27.5%	39	23	41.0%	6.52	4.20	35.6%
MSW	59.75	43.58	27.1%	62	43	30.6%	43	13	69.8%	9.02	2.72	69.8%

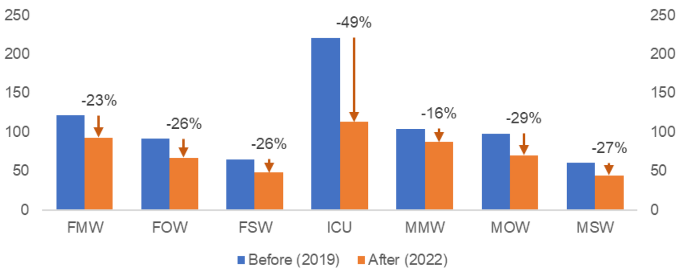

Figure 2. Departmental trolley preparation time reduction after implementation of EHR.

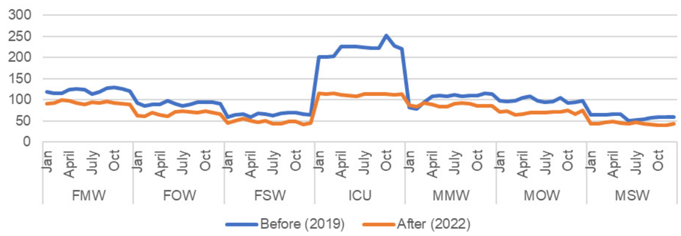

Figure 3. Average time spent on trolley preparation across all months in 2019 and 2022 in each department.

minutes (SD=7.96) before EHR implementation to 92.92 minutes (SD=4.88) after EHR implementation. This 28.35-minute decrease was statistically significant (Z=−16.559, p<0.001). Similarly, in the FOW, a significant decrease in mean dispensing time from 90.90 minutes (SD=6.94) to 67.48 minutes (SD=6.02) was observed after EHR implementation, reflecting a 25.8% reduction (Z=−16.514, p<0.001). The FSW also showed a comparable reduction, with a mean dispensing time reduction from 64.90 minutes (SD=4.63) before EHR implementation to 47.56 minutes (SD=4.51) after EHR implementation. This 26.7% decrease of 17.34 minutes was statistically significant (Z=−16.562, p<0.001).

Among all departments, the ICU exhibited the largest decline in mean dispensing time, from 221.30 minutes (SD=15.42) before EHR implementation to 112.64 minutes (SD=3.27) after EHR implementation. This 108.66-minute reduction (49.1%) was statistically significant (Z=−16.558, p<0.001). In the MMW, the mean dispensing time decreased significantly from 104.45 minutes (SD=13.70) before EHR implementation to 87.37 minutes (SD=4.59) after EHR implementation, reflecting a 16.3% reduction (Z=−14.454, p<0.001). Similarly, the MOW showed a substantial 28.4% decline in mean dispensing time, from 98.19 minutes (SD=6.52) before EHR implementation to 70.21 minutes (SD=4.20) after EHR implementation. This 27.98-minute decrease was statistically significant (Z=−16.538, p<0.001). Finally, in the MSW, the mean dispensing time decreased significantly from 59.75 minutes (SD=9.02) before EHR implementation to 43.58 minutes (SD=2.72) after EHR implementation. This 27.1% reduction (16.17 minutes) was statistically significant (Z=−16.215, p<0.001). Figure 3 shows the average time spent on preparation for each selected ward per month.

Hypotheses testing

Normality tests: The normality of the data for the 7 BCH departments across both time points was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. The results show that for all the 7 departments, the data deviated significantly from a normal distribution in both the pre-EHR and post-EHR periods. This is indicated by the low p values (all <0.001) in each case. Therefore, non-parametric tests were chosen to test the hypotheses. Table 6 summarises the normality test results.

Wilcoxon signed-rank test results: Across all the departments tested, the results provide strong evidence to reject the null hypothesis, which posits that the medication dispensing time does not significantly differ. Specifically, the Z scores ranged from −14.454 to −16.562, and p values were consistently below the 0.001 threshold, as detailed in Table 7. Instead, the data support the alternative hypothesis, suggesting a significant reduction in medication dispensing time after the implementation of EHRs across all selected departments.

Discussion

New and important aspects

This study makes a valuable contribution to the scientific literature by investigating the impact of EHR adoption on medication dispensing times in an understudied context, specifically in a pharmacy department within a hospital in Saudi Arabia. Much of the existing research on EHR implementation originated from Western healthcare systems, with limited evidence from non-Western countries [71]. This study helps address this research gap by providing insights into the consequences of digitalisation in a Middle Eastern healthcare setting. The research also focuses on an under-examined outcome, medication dispensing time, rather than on more general measures such as length of hospital stay or patient satisfaction, which have been emphasised in earlier studies [72-75]. By focusing specifically on medication dispensing time, this study provides targeted evidence regarding the potential for EHR systems to improve this critical pharmacy process.

The large sample size of the study, encompassing over 5,000 medication dispensing timestamps across 365 days before and after the EHR rollout, lends credibility to the findings by facilitating a robust statistical analysis.

Table 6. Tests of normality for both before and after EHR Implementation department wise.

	Department	Kolmogorov-Smirnov[a]			Shapiro-Wilk			Normality
		Statistic	df	Sig.	Statistic	df	Sig.	
Before (2019)	FMW	. 061	365	.003	.992	365	.049	Not Normal
	FOW	. 061	363	.001	.994	363	.139	Not Normal
	FSW	. 120	365	.000	.936	365	.000	Not Normal
	ICU	. 060	365	.003	.984	365	.000	Not Normal
	MMW	. 181	362	.000	.871	362	.000	Not Normal
	MOW	. 153	364	.000	.922	364	.000	Not Normal
	MSW	. 122	365	.000	.963	365	.000	Not Normal
After (2022)	FMW	. 073	365	.000	.986	365	.001	Not Normal
	FOW	. 070	363	.000	.991	363	.035	Not Normal
	FSW	. 118	365	.000	.970	365	.000	Not Normal
	ICU	. 148	365	.000	.935	365	.000	Not Normal
	MMW	. 096	362	.000	.983	362	.000	Not Normal
	MOW	. 107	364	.000	.960	364	.000	Not Normal
	MSW	. 120	365	.000	.969	365	.000	Not Normal

a: Lilliefors Significance Correction

Table 7. Descriptive statistics, wilcoxon signed-rank test results and hypothesis test results by departments.

		N		Mean	Std.Deviation	Minimum	Maximum
FMW	Before (2019)	365		121.27	7.961	103	144
	After (2022)	365		92.92	4.881	75	104
	Z		-16.559				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				
		N		Mean	Std. Deviation	Minimum	Maximum
FOW	Before (2019)	365		90.9	6.94	73	110
	After (2022)	365		67.48	6.019	53	86
	Z		-16.562				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				
		N		Mean	Std. Deviation	Minimum	Maximum
FSW	Before (2019)	365		64.9	4.633	46	77
	After (2022)	365		47.56	4.508	38	57
	Z		-16.559				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				
		N		Mean	Std. Deviation	Minimum	Maximum
ICU	Before (2019)	365		221.3	15.419	186	266
	After (2022)	365		112.64	3.271	96	118
	Z		-16.558b				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				
		N		Mean	Std. Deviation	Minimum	Maximum
MMW	Before (2019)	364		104.45	13.695	58	125
	After (2022)	364		87.37	4.591	76	98
	Z		-14.454b				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				
		N		Mean	Std. Deviation	Minimum	Maximum
MOW	Before (2019)	365		98.19	6.518	84	123
	After (2022)	365		70.21	4.203	62	85
	Z		-16.538b				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				
		N		Mean	Std. Deviation	Minimum	Maximum
MSW	Before (2019)	365		59.75	9.022	34	77
	After (2022)	365		43.58	2.715	38	51
	Z		-16.215b				
	P-value		.000				
	Hypothesis test result		Reject the null hypothesis				

Comparison with previous studies

The results of the present study showed that expedited medication dispensing aligns with and reinforces similar findings on EHR benefits in previous studies. A systematic review by Campanella P, et al. [3] uncovered significant evidence that EHR adoption is associated with enhanced quality and efficiency of healthcare delivery. By examining pharmacy operations, Monroe CD and Chin KY found that an EHR system in specialised pharmacy care led to substantial reductions in turnaround times for medication orders and improved order accuracy within a US hospital [6]. Another research was conducted to evaluate the perception of Finnish pharmacists towards an electronic prescription system [76]. The findings revealed that a significant number of pharmacists acknowledged the favourable influence of the electronic system in enhancing the efficiency of the medication dispensation procedure [76]. The enhanced efficiency of the dispensing procedure could be credited to the digitalisation of the medication dispensation workflow; using an electronic system reduces reliance on manual, paper-based processes, allowing pharmacists to input dispensing entries into the electronic prescription immediately [76-78].

Moreover, research by Mekhjian HS, et al. conducted at Ohio State University found that implementing an electronic prescribing technology led to a significant decrease of 70% in medication turnaround time during the dispensing phase [39]. The dispensing time was decreased from 3 hours and 16 minutes to 1 hour and 22 minutes [39]. In addition, the total turnover time for pharmaceuticals was considerably reduced from approximately five hours to less than two hours, demonstrating a substantial improvement in operational efficiency [39].

A parallel study by Lehman ML, et al. found a statistically significant decrease of 64% in medication turnaround time after the implementation of CPOE [79]. The mean duration declined from approximately three hours and fifty minutes to just over one hour and twenty minutes, resulting in a total reduction of around two and a half hours [79]. Franklin BD, et al. compared medication supply time between before and after implementation of electronic prescribing and found a significant reduction [40]. Before implementation, the time allocated to this process was 2 hours and 2 minutes [40]. After deployment of electronic prescribing, the observed time reduction was 13.5% of the overall duration, almost equivalent to 1 hour and 50 minutes, indicating that computerised prescription systems improve medication dispensing efficiency [40].

This study found that the ICU experienced the most substantial improvement in dispensing time after EHR implementation compared with the other departments examined. This significant improvement could be attributed to several enhancements enabled by integrating technology into pharmacy workflows [80]. Such enhancements include reduced time in locating charts, fewer inquiries from unclear orders, and faster access to clinical information [80]. A research by Fitzpatrick R, et al. found a 17% decrease in weekly dispensing time with automated systems, from 349.0 hours to 290.0 hours, demonstrating increased pharmacy efficiency [81]. Another explanation might be that ICU patients are often prescribed numerous medications [82]. So EHR-enabled enhancements such as computerised order entry and medication reconciliation may confer disproportionate benefits, highlighting the value of EHRs in optimising processes and improving time-related metrics [83-85].

Across other contexts, EHR implementation has been linked to various operational improvements, including decreased laboratory and radiology test turnaround times [25,39,86-89]. While research has been somewhat limited in non-Western nations, some studies in the Middle East have produced findings comparable with those of the present study regarding EHR benefits. A study in Saudi Arabia found that introducing healthcare technology for facilitating radiology requests and reporting was associated with positive turnaround times and fewer delays [90]. Another Saudi Arabian physician-perspective study revealed perceived enhancements in care quality and efficiency following the transition from paper to electronic documentation using EHRs [91]. Accordingly, the conclusions of this study align with the positive impacts detected across similar healthcare digitalisation efforts regionally and globally.

In contrast to the present study, the research by Cartmill RS, et al. found that while electronic order management decreased the time from ordering to pharmacy verification (from 137 minutes to 51 minutes) and from ordering to administration (306 minutes to 188 minutes), it did not significantly affect the pharmacy dispensing time [92]. The rationale for this might be attributed to the time-consuming nature of electronically rectifying medication errors, the necessity of communicating with physicians for correction, and the technological challenges that sometimes accompany the use of technology [76]. Furthermore, Jensen conducted retrospective research to examine the medication turnaround times in a specific ward of a large metropolitan hospital in the United States before and after the installation CPOE, a technology integrated into EHRs [93]. The study revealed a significant reduction of 23% in the mean duration for medication processing, dropping from around seven to just over five hours [93]. Nevertheless, time-saving advantages were constrained solely to the initial ordering stage and did not include the dispensing stage, as the author did not find significant differences in dispensing time [93]. Unlike the findings of the present study, EHR adoption did not automatically improve all medication dispensing workflow segments without additional operational changes. One possible explanation could be the transitional adjustment period, as it is often required for clinicians and staff to become proficient in new electronic workflows, which can pose initial challenges [94].

The present research underscores the salience of specific EHR functionalities in streamlining medication-related workflows. For instance, CPOE has been shown to facilitate clinicians' prescribing behaviours directly through the EHR system, thereby obviating the need for handwritten orders [6,95]. Likewise, barcode-assisted dispensing and robust medication reconciliation functionalities have also been shown to be instrumental in enhancing safety measures [8,10]. However, it is critical to be mindful of the potential drawbacks. While CPOE may ameliorate legibility issues, poorly designed interfaces can introduce novel types of errors [12]. Similarly, inflexible decision support can result in alert fatigue, consequently leading clinicians to dismiss system warnings [96]. This highlights that while EHRs carry substantial potential, realising their benefits depends on careful system selection, workflow analysis, user-centred design, extensive training, and ongoing optimisation. Further research should continue to elucidate the best practices surrounding EHR implementation and use for improving the efficiency and safety of medication management.

Implications for practice and future research

This study provides practitioners with encouraging evidence that thoughtfully executed EHR implementation with the engagement of pharmacy staff can meaningfully enhance core dispensing workflows. The time savings unlocked could allow pharmacists to dedicate more attention to direct patient-care activities. As the first study of its kind in Saudi Arabia, this research offers a model for healthcare leaders and policymakers, especially in Saudi Arabia, who are considering adopting or upgrading EHR systems to anticipate future results.

Limitations and Recommendations

Some important limitations provide opportunities for future research. First, the use of secondary data from a single site limits generalisability. Follow-up studies should evaluate the impacts of EHRs on dispensing times across multiple hospitals and in varying contexts. Second, it would be informative to divide the data according to different types of medications, departments, or patient conditions to discern if impacts differ. Third, the effects on metrics beyond time, such as order accuracy and staff workload, should also be investigated. Fourth, future research could examine long-term time trends, rather than just the year immediately before and after EHR implementation, to understand changes over an extended period. Qualitative data through surveys or interviews would provide insights into the user experiences and workflow changes underpinned by the EHR. Addressing these limitations and building on this study will offer richer perspectives on optimising pharmacy operations through digitalisation.

Conclusion

This quasi-experimental pre-post study generated compelling quantitative evidence that implementing an EHR system in the pharmacy of BCH in Saudi Arabia led to substantial reductions in medication dispensing times. The 25.8% average decrease in dispensing time represents a major efficiency gain for this hospital's pharmacy workflows and has tangible implications for enhancing patient safety and care quality. While previous studies have illuminated the benefits of EHR adoption in hospitals, this research makes a specific contribution by focusing on medication dispensing times within an understudied non-Western setting. The findings may guide leaders at similar healthcare institutions in considering investments in digitalisation to streamline pharmacy dispensing procedures. Further research can build on this study to evaluate long-term trends, incorporate qualitative data, and broaden the scope of the metrics and outcomes examined.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Seymour, Tom, Dean Frantsvog and Tod Graeber. "Electronic Health Records (EHR)." *Am J Health Sci* 3 (2012): 201-210.
2. Hillestad, Richard, James Bigelow, Anthony Bower and Federico Girosi, et al. "Can electronic medical record systems transform health care? Potential health benefits, savings and costs." *Health Aff* 24 (2005): 1103-1117.
3. Campanella, Paolo, Emanuela Lovato, Claudio Marone and Lucia Fallacara, et al. "The impact of electronic health records on healthcare quality: A systematic review and meta-analysis." *Eur J Public Health* 26 (2016): 60-64.
4. Nissen, Francis, Jennifer K. Quint, Daniel R. Morales and Ian J. Douglas. "How to validate a diagnosis recorded in electronic health records." *Breathe* 15 (2019): 64-68.
5. Jones, Spencer S., Robert S. Rudin, Tanja Perry and Paul G. Shekelle. "Health information technology: An updated systematic review with a focus on meaningful use." *Ann Intern Med* 160 (2014): 48-54.
6. Monroe, C. Douglas and Karen Y. Chin. "Specialty pharmaceuticals care management in an integrated health care delivery system with electronic health records." *J Manag Care Pharm* 19 (2013): 334-344.
7. Tariq, Rayhan A., Rishik Vashisht, Ankur Sinha and Yevgeniya Scherbak. "Medication dispensing errors and prevention." (2018).
8. Pedersen, Craig A., Philip J. Schneider and Douglas J. Scheckelhoff. "ASHP national survey of pharmacy practice in hospital settings: Dispensing and administration-2008." *Am J Health-Syst Pharm* 66 (2009): 926-946.
9. Aarts, Jos, Joan Ash and Marc Berg. "Extending the understanding of computerized physician order entry: Implications for professional collaboration, workflow and quality of care." *Int J Med Inform* 76 (2007): S4-S13.
10. Grossman, J., Rebecca Gourevitch and Dori A. Cross. "Hospital experiences using electronic health records to support medication reconciliation." National Institute for Healthcare Reform (NIHCR) (2014).
11. Ratwani, Raj M., Erica Savage, Amy Will and Ryan Arnold, et al. "A usability and safety analysis of electronic health records: A multi-center study." *J Am Med Inform Assoc* 25 (2018): 1197-1201.
12. Han, Yong Y., Joseph A. Carcillo, Shekhar T. Venkataraman and Robert SB Clark, et al. "Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system." *Pediatrics* 116 (2005): 1506-1512.
13. Kjeldsen, Lene Juel, Maja Schlünsen, Annette Meijers and Steffan Hansen, et al. "Medication dispensing by pharmacy technicians improves efficiency and patient safety at a geriatric ward at a Danish Hospital: A pilot study." *Pharmacy* 11 (2023): 82.
14. Calder-Sprackman, Samantha, Glenda Clapham, Trisha Kandiah and Jade Choo-Foo, et al. "The impact of adoption of an electronic health record on emergency physician work: A time motion study." *J Am Coll Emerg Physicians Open* 2 (2021): e12362.
15. Sockolow, P. S., K. H. Bowles, M. C. Adelsberger and J. L. Chittams, et al. "Impact of homecare electronic health record on timeliness of clinical documentation, reimbursement and patient outcomes." *Appl Clin Inform* 5 (2014): 445-462.
16. Jha, Ashish K., Timothy G. Ferris, Karen Donelan and Catherine DesRoches, et al. "How common are electronic health records in the United States? A summary of the evidence: About one-fourth of US physician practices are now using an EHR, according to the results of high-quality surveys." *Health Aff* 25 (2006): W496-W507.
17. Jha, Ashish K., Catherine M. DesRoches, Eric G. Campbell and Karen Donelan, et al. "Use of electronic health records in US hospitals." *N Engl J Med* 360 (2009): 1628-1638.
18. McCrorie, Carolyn, Jonathan Benn, Owen Ashby Johnson and Arabella Scantlebury. "Staff expectations for the implementation of an electronic health record system: A qualitative study using normalisation process theory." *BMC Medical Inform Decis Mak* 19 (2019): 1-14.
19. Gagnon, Marie-Pierre, Nicola Shaw, Claude Sicotte and Luc Mathieu, et al. "Users' perspectives of barriers and facilitators to implementing EHR in Canada: A study protocol." *Implement Sci* 4 (2009): 1-8.
20. Yoo, Sooyoung, Kahyun Lim, Se Young Jung and Keehyuck Lee, et al. "Examining the adoption and implementation of behavioral electronic health records by healthcare professionals based on the clinical adoption framework." *BMC Medical Inform Decis Mak* 22 (2022): 1-9.
21. Gagnon, Marie-Pierre, Mathieu Ouimet, Gaston Godin and Michel Rousseau, et al. "Multi-level analysis of electronic health record adoption by health care professionals: A study protocol." *Implement Sci* 5 (2010): 1-10.
22. Cheung, Ka-Chun, Marcel L. Bouvy and Peter AGM De Smet. "Medication errors: The importance of safe dispensing." *Br J Clin Pharmacol* 67 (2009): 676-680.
23. Chuang, Sara, Kate Lorraine Grieve and Vivienne Mak. "Analysis of dispensing errors made by first-year pharmacy students in a virtual dispensing assessment." *Pharmacy* 9 (2021): 65.
24. Middleton, Blackford, W. Ed Hammond, Patricia F. Brennan and Gregory F. Cooper. "Accelerating US EHR adoption: How to get there from here. Recommendations based on the 2004 ACMI retreat." *J Am Med Inform Assoc* 12 (2005): 13-19.
25. Jamoom, Eric W., Vaishali Patel, Michael F. Furukawa and Jennifer King. "EHR adopters *vs.* non-adopters: Impacts of, barriers to and federal initiatives for EHR adoption." In Healthcare; Elsevier 2(2014) 33-39.
26. Ngusie, Habtamu Setegn, Sisay Yitayih Kassie, Alex Ayenew Chereka and Ermias Bekele Enyew. "Healthcare providers' readiness for electronic health record adoption: A cross-sectional study during pre-implementation phase." *BMC Health Serv Res* 22 (2022): 1-12.
27. Noor, Adeeb. "The utilization of e-health in the Kingdom of Saudi Arabia." *Int Res J Eng Technol* 6 (2019): 11.
28. Buntin, Melinda Beeuwkes, Matthew F. Burke, Michael C. Hoaglin and David Blumenthal. "The benefits of health information technology: A review of the recent literature shows predominantly positive results." *Health Aff* 30 (2011): 464-471.
29. Kaushal, R. and D. Bates. "Information technology and medication safety: What is the benefit?." *Qual Saf in Health Care* 11 (2002): 261.
30. Angelo, Lauren B., Dale B. Christensen and Stefanie P. Ferreri. "Impact of community pharmacy automation on workflow, workload and patient interaction." *J Am Pharm Assoc* 45 (2005): 138-144.
31. Zhou, Li, Christine S. Soran, Chelsea A. Jenter and Lynn A. Volk, et al. "The relationship between electronic health record use and quality of care over time." *J Am Med Inform Assoc* 16 (2009): 457-464.
32. Chaudhry, Basit, Jerome Wang, Shinyi Wu and Margaret Maglione, et al. "Systematic review: Impact of health information technology on quality, efficiency and costs of medical care." *Ann Intern Med* 144 (2006): 742-752.
33. Ammenwerth, Elske, Petra Schnell-Inderst, Christof Machan and Uwe Siebert. "The effect of electronic prescribing on medication errors and adverse drug events: A systematic review." *J Am Med Inform Assoc* 15 (2008): 585-600.

34. Lindsay, Mary R. and Kay Lytle. "Implementing best practices to redesign workflow and optimize nursing documentation in the electronic health record." *Appl Clin Inform* 13 (2022): 711-719.

35. Ni, Yizhao, Todd Lingren, Hannah Huth and Kristen Timmons, et al. "Integrating and evaluating the data quality and utility of smart pump information in detecting medication administration errors: Evaluation study." *JMIR Med Inform* 8 (2020): e19774.

36. Poissant, Lise, Jennifer Pereira, Robyn Tamblyn and Yuko Kawasumi. "The impact of electronic health records on time efficiency of physicians and nurses: A systematic review." *J Am Med Inform Assoc* 12 (2005): 505-516.

37. Sinsky, Christine, Lacey Colligan, Ling Li and Mirela Prgomet, et al. "Allocation of physician time in ambulatory practice: A time and motion study in 4 specialties." *Ann Intern Med* 165 (2016): 753-760.

38. Poon, Eric G., Carol A. Keohane, Catherine S. Yoon and Matthew Ditmore, et al. "Effect of bar-code technology on the safety of medication administration." *N Engl J Med* 362 (2010): 1698-1707.

39. Mekhjian, Hagop S., Rajee R. Kumar, Lynn Kuehn and Thomas D. Bentley, et al. "Immediate benefits realized following implementation of physician order entry at an academic medical center." *J Am Med Inform Assoc* 9 (2002): 529-539.

40. Franklin, Bryony Dean, Kara O'Grady, Parastou Donyai and Ann Jacklin, et al. "The impact of a closed-loop electronic prescribing and automated dispensing system on the ward pharmacist's time and activities." *Int J Pharm Pract* 15 (2007): 133-139.

41. Campbell, Emily M., Kenneth P. Guappone, Dean F. Sittig and Richard H. Dykstra, et al. "Computerized provider order entry adoption: Implications for clinical workflow." *J Gen Intern Med* 24 (2009): 21-26.

42. Nanji, Karen C., Jeffrey M. Rothschild, Jennifer J. Boehne and Carol A. Keohane, et al. "Unrealized potential and residual consequences of electronic prescribing on pharmacy workflow in the outpatient pharmacy." *J Am Med Inform Assoc* 21 (2014): 481-486.

43. Moniz, Thomas T., Andrew C. Seger, Carol A. Keohane and Dianel Lew Seger, et al. "Addition of electronic prescription transmission to computerized prescriber order entry: Effect on dispensing errors in community pharmacies." *Am J Health-Syst Pharm* 68 (2011): 158-163.

44. Palchuk, Matvey B., Elizabeth A. Fang, Janet M. Cygielnik and Matthew Labreche, et al. "An unintended consequence of electronic prescriptions: Prevalence and impact of internal discrepancies." *J Am Med Inform Assoc* 17 (2010): 472-476.

45. Odukoya, Olufunmilola K. and Michelle A. Chui. "Relationship between e-prescriptions and community pharmacy workflow." *J Am Pharm Assoc* 52 (2012): e168-e174.

46. Hollingworth, William, Emily Beth Devine, Ryan N. Hansen and Nathan M. Lawless, et al. "The impact of e-prescribing on prescriber and staff time in ambulatory care clinics: A time-motion study." *J Am Med Inform Assoc* 14 (2007): 722-730.

47. Koppel, Ross, Joshua P. Metlay, Abigail Cohen and Brian Abaluck, et al. "Role of computerized physician order entry systems in facilitating medication errors." *Jama* 293 (2005): 1197-1203.

48. Alanazi, Abdullah, Mohamud Mohamud and Bakheet Aldosari. "Establishing a graduate certificate in health informatics: Need assessment and competency-based framework." *Acta Inform Med* 30 (2022): 184.

49. Al-Hanawi, Mohammed Khaled and Innocent F. Makuta. "Changes in productivity in healthcare services in the Kingdom of Saudi Arabia." *Cost Eff Resour Alloc* 20 (2022): 3.

50. Hwang, Soohyun, Sarah A. Birken, Cathy L. Melvin and Catherine L. Rohweder, et al. "Designs and methods for implementation research: Advancing the mission of the CTSA program." *Clin Transl Sci* 4 (2020): 159-167.

51. Harris, Anthony D., Jessina C. McGregor, Eli N. Perencevich and Jon P. Furuno, et al.. "The use and interpretation of quasi-experimental studies in medical informatics." *J Am Med Inform Assoc* 13 (2006): 16-23.

52. Schweizer, Marin L, Barbara I Braun and Aaron M Milstone. "Research methods in healthcare epidemiology and antimicrobial stewardship quasi-experimental designs." *Infect Control Hosp Epidemiol* 37 (2016): 1135-1140.

53. White, Howard and Shagun Sabarwal. "Quasi-experimental design and methods." Methodological briefs: Impact evaluation 8 (2014): 1-16.

54. Bernal, James Lopez, Steven Cummins and Antonio Gasparrini. "Interrupted time series regression for the evaluation of public health interventions: A tutorial." *Int J Epidemiol* 46 (2017): 348-355.

55. Etikan, Ilker, Sulaiman Abubakar Musa and Rukayya Sunusi Alkassim. "Comparison of convenience sampling and purposive sampling." *Am J Theor Appl Stat* 5 (2016): 1-4.

56. Battaglia, Michael, N. Sampling and PJ Lavrakas. "Encyclopedia of survey research methods." Publication date (2008).

57. Jager, Justin, Diane L. Putnick and Marc H. Bornstein. "II. More than just convenient: The scientific merits of homogeneous convenience samples." *Monogr Soc Res Child Dev* 82 (2017): 13-30.

58. Bujang, Mohamad Adam, Puzziawati Ab Ghani, Nur Amirah Zolkepali and Tassha Hilda Adnan, et al. "A comparison between convenience sampling *vs.* systematic sampling in getting the true parameter in a population: Explore from a clinical database: the Audit Diabetes Control Management (ADCM) registry in 2009." *ICSSBE* (2012): 1-5.

59. Safran, Charles, Meryl Bloomrosen, W. Edward Hammond and Steven Labkoff, et al. "Toward a national framework for the secondary use of health data: An American Medical Informatics Association White Paper." *J Am Med Inform Assoc* 14 (2007): 1-9.

60. Connelly, Roxanne, Christopher J Playford, Vernon Gayle and Chris Dibben. "The role of administrative data in the big data revolution in social science research." *Soc Sci Res* 59 (2016): 1-12.

61. Johnston, Melissa P. "Secondary data analysis: A method of which the time has come." Qualitative and Quantitative Methods in Libraries 3 (2014): 619-626.

62. Smith, Emma. "Pitfalls and promises: The use of secondary data analysis in educational research." *Br J Educ Stud* 56 (2008): 323-339.

63. Windle, Pamela E. "Secondary data analysis: Is it useful and valid?." *J Perianesth Nurs* 25 (2010): 322-324.

64. Schneeweiss, Sebastian, H-G. Eichler, A. Garcia-Altes and C. Chinn, et al. "Real world data in adaptive biomedical innovation: A framework for generating evidence fit for decision-making." *Clin Pharmacol Ther* 100 (2016): 633-646.

65. Brown, Angus M. "A step-by-step guide to non-linear regression analysis of experimental data using a Microsoft excel spreadsheet." *Comput Methods Programs Biomed* 65 (2001): 191-200.

66. Nijhawan, Lokesh P., Manthan D. Janodia, B. S. Muddukrishna and Krishna Moorthi Bhat, et al. "Informed consent: Issues and challenges." *J Adv Pharm Technol Res* 4 (2013): 134.

67. Levesque, Raynald. "SPSS programming and data management: A guide for SPSS and SAS users." *Spss* (2005).

68. Vickers, Andrew J. "Parametric *vs.* non-parametric statistics in the analysis of randomized trials with non-normally distributed data." *BMC Med Res Methodol* 5 (2005): 1-12.

69. Shieh, Gwowen, Show-Li Jan and Ronald H. Randles. "Power and sample size determinations for the Wilcoxon signed-rank test." *J Stat Comput Simul* 77 (2007): 717-724.

70. Ghadhban, Ghufran A. and Huda A. Rasheed. "Robust tests for the mean difference in paired data using Jackknife resampling technique." *Iraqi J Sci* (2021): 3081-3090.

71. Kruse, Clemens Scott, Caitlin Kristof, Beau Jones and Angelica Martinez, et al. "Barriers to electronic health record adoption: A systematic literature review." *J Med Syst* 40 (2016): 1-7.

72. Stubbs, Daniel J., Benjamin M. Davies, Tom Bashford and Rowan M. Burnstein, et al. "Identification of factors associated with morbidity and postoperative length of stay in surgically managed chronic subdural haematoma using electronic health records: A retrospective cohort study." *BMJ Open* 10 (2020): e037385.

73. LaRoché, Karen D., Carl R. Hinkson, Brett A. Thomazin and David J. Carlbom, et al. "Impact of an electronic medical record screening tool and therapist-driven protocol on length of stay and hospital readmission for COPD." *Respir Care* 61 (2016): 1137-1143.

74. Liu, Jialin, Li Luo, Riu Zhang and Tingting Huang. "Patient satisfaction with electronic medical/health record: A systematic review." *Scand J Caring Sci* 27 (2013): 785-791.

75. Irani, Jihad S., Jennifer L. Middleton, Ruta Marfatia and Frank D'Amico, et al. "The use of electronic health records in the exam room and patient satisfaction: A systematic review." *J Am Board Fam Med* 22 (2009): 553-562.

76. Kauppinen, Hanna, Riitta Ahonen and Johanna Timonen. "The impact of electronic prescriptions on the medicine dispensing process in Finnish community pharmacies-a survey of pharmacists." *J Pharm Health Serv Res* 8 (2017): 169-176.

77. Hammar, Tora, Sofie Nyström, Göran Petersson and Bengt Åstrand, et al. "Swedish pharmacists value ePrescribing: A survey of a nationwide implementation." *J Pharm Health Serv Res* 1 (2010): 23-32.

78. Rahimi, Bahlol and Toomas Timpka. "Pharmacists' views on integrated electronic prescribing systems: Associations between usefulness, pharmacological safety and barriers to technology use." *Eur J Clin Pharmacol* 67 (2011): 179-184.

79. Lehman, Martha L., John H. Brill, P. C. Skarulis and Cindy Lee, et al. "Physician order entry impact on drug turn-around times." In Proceedings of the AMIA Symposium. Am Med Inform Assoc (2001):359.

80. Lo, Connie, Rosemary Burke and Johanna I. Westbrook. "Electronic medication management systems' influence on hospital pharmacists' work patterns." *J Pharm Pract Res* 40 (2010): 106-110.

81. Fitzpatrick, Ray, Peter Cooke, Carol Southall and K. Kaudhar, et al. "Evaluation of an automated dispensing system in a hospital pharmacy dispensary." *Pharm J* 274 (2005).

82. Sikora, Andrea, Deepak Ayyala, Megan A. Rech and Sarah B. Blackwell, et al. "Impact of pharmacists to improve patient care in the critically ill: A large multicenter analysis using meaningful metrics with the Medication Regimen Complexity-ICU (MRC-ICU) score." *Crit Care Med* 50 (2022): 1318-1328.

83. Kaushal, Rainu, Kaveh G. Shojania and David W. Bates. "Effects of computerized physician order entry and clinical decision support systems on medication safety: A systematic review." *Arch Intern Med* 163 (2003): 1409-1416.

84. McCullough, Jeffrey S., Michelle Casey, Ira Moscovice and Shailendra Prasad. "The effect of health information technology on quality in US hospitals." *Health Aff* 29 (2010): 647-654.

85. Horsky, Jan, Elizabeth A. Drucker and Harley Z. Ramelson. "Higher accuracy of complex medication reconciliation through improved design of electronic tools." *J Am Med Inform Assoc* 25 (2018): 465-475.

86. Petrides, Athena K., Ida Bixho, Ellen M. Goonan and David W. Bates, et al. "The benefits and challenges of an interfaced electronic health record and laboratory information system: Effects on laboratory processes." *Arch Pathol Lab Med* 141 (2017): 410-417.

87. Baron, Jason M. and Anand S. Dighe. "Computerized provider order entry in the clinical laboratory." *J Pathol Inform* 2 (2011): 35.

88. Sachs, Peter B. and Graham Long. "Process for managing and optimizing radiology work flow in the electronic Heath record environment." *J Digit Imaging* 29 (2016): 43-46.

89. Niazkhani, Zahra, Habibollah Pirnejad, Marc Berg and Jos Aarts. "The impact of computerized provider order entry systems on inpatient clinical workflow: A literature review." *J Am Med Inform Assoc* 16 (2009): 539-549.

90. Almutairi, Fahad and Jaber Alyami. "Impact of radiology information system on CT scan reporting time." *Open J Med Imaging* 11 (2021): 73-84.

91. Khudair, A. A. "Electronic health records: Saudi physicians' perspective." In 2008 5th IET Seminar on Appropriate Healthcare Technologies for Developing Countries. *IET* 2008:1-7

92. Cartmill, Randi S., James M. Walker, Mary Ann Blosky and Roger L. Brown, et al. "Impact of electronic order management on the timeliness of antibiotic administration in critical care patients." *Int J Med Inform* 81 (2012): 782-791

93. Jensen, Jeffery R. "The effects of computerized provider order entry on medication turn-around time: A time-to-first dose study at the providence Portland medical center." In AMIA Annual Symposium Proceedings. *Am Med Inform Assoc* 2006:384

94. Boswell, Robert A. "Implementing electronic health records: Implications for HR professionals." Strategic HR Review 12 (2013): 262-268.

95. Elsaid, Khaled A., Steven Garguilo and Christine M. Collins. "Chemotherapy e-prescribing: Opportunities and challenges." *Integr Pharm Res Pract* (2015): 39-48.

96. Van Der Sijs, Heleen, Jos Aarts, Arnold Vulto and Marc Berg. "Overriding of drug safety alerts in computerized physician order entry." *J Am Med Inform Assoc* 13 (2006): 138-147.

How to cite this article: Alanazi, Turki Hamoud. "How has the Implementation of the Electronic Health Records (EHRs) Affected the Medication Dispensing Time in the in-patient Pharmacy Department at Buraydah Central Hospital, Kingdom of Saudi Arabia? A Quasi-Experimental Study." *J Health Med Informat* 15 (2024): 507.