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ORIGINAL RESEARCH

Trends and Types of Medical Errors Reporting Following the Implementation of Electronic Health Record System

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Introduction: Constant supervision is required in a hospital setting because medication errors are a common occurrence and can be potentially harmful to patients.

Objective: To examine patterns in medication error rates, types, and departmental distributions at tertiary hospitals from 2013 to 2023.

Methods: In this cross-sectional research, the internal hospital medication error database was utilized, collecting data on dosage errors which included Wrong Dose, Drug Omission, Timing Error, and the departments assignment of errors include ICU, General Ward, Pharmacy, Emergency Department for a continuous duration of 11 years.

Results: The reports for medication errors at tertiary hospitals for the years 2013–2023 altogether displayed fairly consistent behavior. Maximum error count was in the year 2019 with 6108 errors while the minimum was in the year 2015 with errors summing up to 725. The results showed fallen in medication errors to 1279 errors by 2023. Important types of errors were wrong/unclear dose prescriptions that used to peak in 2019 with 1307 and also duplication of medication errors increased with 297 additional errors between 2013 to 2023. The changes between types of errors made ($\chi^2 = 1297.75$, p-value < 0.001), hospital centers ($\chi^2 = 1668.97$, p-value < 0.001) and sections of the hospital in which they were carried out ($\chi^2 = 3086.19$, p-value < 0.001) proved vital through chi-square tests done and thus showcasing the shifting control of medication error detection and reporting brought by electronic health record (EHRs) system and training.

Conclusion: Medication errors showed variability with peaks, troughs, and fluctuations, demonstrating the inter-year coping mechanisms of EHRs system and personnel. Decision makers need to improve the system alongside staff education and some focused departmental attention. Although there has been some improvement in reporting errors, reporting new emerging errors, such as duplication of procedures, necessitates further vigilance in the dispensation of services to patients.

Keywords: medication errors, medical error reports, electronic health records, hospital databases, medical error trends

Introduction

The Electronic Health Records (EHRs) system has significantly transformed the delivery of healthcare globally through enhancing patient care, guaranteeing data accuracy and making sure that there is efficiency in workflow. In Saudi Arabia, the healthcare sector has in the recent past adopted and integrated EHRs with the aim of improving general operational efficiency and the safety of patients.[1] One of the major areas of concern in the delivery and management of care is errors in the administration of medication and that it can bring about adverse drug events that not only compromise patient outcomes but further escalate the costs of healthcare.[2]

The adoption of computerized physician order entry (CPOE) systems has significantly reduced the rate of medication errors over time. The systems are able to accomplish this through providing real-time access to patient information while

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at the same time providing automated alerts in case of potential negative drug interactions.[3] Another point to note is that the implementation of EHRs across hospitals typically enhances the general quality of medication management and that it has been able to positively influence healthcare practices despite the emergence of challenges such as the need for staff training and system usability.[4] Despite the general positive reception that EHRs have received in Saudi Arabia, the medical facilities across the region still have to contend with several implementation challenges.[5] In this regard, the facilities are encouraged to make sure that they facilitate the continuous training of their employees while at the same time embracing the optimization of their systems to maintain efficiency and reduce any potential errors.

Several studies have over time sought to investigate the influence that the implementation of EHRs have on the frequency of the reporting of medication errors. Naamneh and Abodas (2024) determined that the introduction of EHRs had a significant reduction on the frequency of the medication errors. In particular, the study determined that the EHRs enhanced the accuracy with which the medications were being administered.[6] At the same time, two studies determined that the EHRs often enhanced the medication management practices and further contributed to a reduction in the incidence of the medication errors that were being reported across different settings.[4,7]

Studies have found that EHRs have been effective in the reduction of particular forms of medication errors such as transcription as well as dispensing errors. Moreover, the study determined that EHRs that have been integrated with clinical decision support tools were quite effective in the prevention of errors that are associated with allergies and drug interactions. However, the scholars noted that the EHRs were likely to introduce new forms of errors such as those that are related to system usability and data entry and this means that health facilities should work towards equipping their personnel with the skills that they require to effectively navigate the systems.[8,9]

The accuracy along with the completeness of medication error reports is vital in undertaking effective error management as well as prevention. Osamani and others (2023) found that the adoption of EHRs enhanced the accuracy of medication error reports through the reduction of manual entry errors while further making sure that all the necessary information was captured given the use of the templates. The scholar further notes that despite the effectiveness of the systems, the reports are likely to be compromised in case the users do not receive adequate training.[10]

Despite the benefits that have been associated with the adoption of EHRs, there are several challenges that are associated with this form of technology and one of the primary challenges is associated with the usability of the system. Adams et al (2021) contend that there are several issues such as slow system response times as well as complex interfaces and the lack of integration into other systems that inhibit the effective use of EHRs in the reporting of errors.[11] Adeniyi et al (2024) agrees and highlights the initial phase in the implementation of EHRs is often likely to be challenging because the users often need considerable time for them to adapt to the new forms of technology.[12] Reegu et al (2022) further note that users are unwilling to accept new technology, which could derail the adoption of technologies, such as blockchain to improve the implementation of EHRs. The scholars further note that there is a challenge when it comes to the potential overload of the data and this means that the sheer volume of information that is routinely captured by the EHRs can often make it challenging for the users to identify and report the errors in an accurate manner.[13]

The significance of the study primarily lies in its potential to enhance the safety of patients, quality of care and the degree of operational efficiency through improvement in medication error reporting. The study will be able to provide insights into the manner in which digital documentation enhances accuracy while at the same time reducing human errors and streamlining the reporting processes. In addition, the study will prove valuable for the healthcare providers who are seeking to enhance their clinical workflows, thereby guaranteeing better compliance with the protocols of patient safety. At the same time, policymakers along with hospital administrators will be able to employ the insights in refining the existing healthcare strategies and further implementing the best practices while further fostering a culture of accountability and safety across hospital settings. Therefore, this study aims to examine patterns in medication error rates, types, and departmental distributions at tertiary hospitals from 2013 to 2023.

Methods

Study Design

The study adopted a cross-sectional design with the aim of analyzing the trends of medication error at the 1200-bed hospital from 2013 to December 2023. The researcher collected data on error incidents from the hospital database, and the information captured the monthly error counts, error types and the departments that were involved such as ICU and general ward as well as pharmacy and emergency department. The cross-sectional approach involved the assessment of the variables across particular intervals over the course of the study period in order to determine the trends and the patterns in error distributions. The cross-sectional design is ideal for the study, and this is because it efficiently captures a snapshot of the characteristics of medication error across several years and this enables the identification of trends without requiring prolonged data collection periods.

This approach no doubt aligns with the goal of the study on the examination of error types and the departmental patterns and this provides a robust view of the dynamics of patient safety. Through sampling data at discrete intervals, the study brought on board a dataset with diverse variables that supported statistical analyses such as chi-square tests. Another point is that the feasibility of the design across a busy hospital setting has no doubt made it possible for the researcher to collect robust data while at the same time minimizing any form of disruption and this makes it ideal for the study. It should further be noted that the cross-sectional design supports the exploratory objectives of the study and this means that there is simultaneous analysis of different factors such as the types of errors and the departments as well as the time points.[14] Despite the fact that it is somewhat limited when it comes to the proof of causation, the design has brought about some descriptive strength.

Study Area

The study was undertaken at tertiary hospitals that are located in Riyadh. The study spanned a period of twelve months with data collection and processing as well as statistical comparison as well as qualitative assessment being done from 2013 to 2023. The study population mainly comprised of patients that were treated at tertiary hospitals.

The inclusion criteria are that the medication error reports were from tertiary hospitals and that it was vital for them to have documented within the specified study duration. At the same time, the reports had to include appropriate details that supported analysis, and this included the type of error as well as the factors that contributed along with the outcome. The medication error reports were excluded from the study in case they were incomplete or insufficiently detailed and those that were determined from outside the specified study period.

Statistical Analysis

To estimate the proportions of medication errors we needed a sample size of 385. This number is based on the Cochrane formula

$$n = p(1-p)(Z_{.975}/m)^2$$

with $p = 0.04$ and $m = 5\%$

Quantitative data were mainly collected through undertaking an analysis of the medication error reports that were obtained from the hospital databases and the variables that were analyzed include the type of error and the stage of the medication process as well as the severity of the errors. The data were obtained from Datix risk management and incident reporting platform, within the hospital. The analysis examined medication error reports from tertiary hospitals in Riyadh, Saudi Arabia, through Datix risk management and incident reporting for 11 years (2013–2023) after their EHRs system launch. An 11-years (2013–2023) retrospective analysis of incident reports at tertiary hospitals in Riyadh, Saudi Arabia, used Datix risk management systems to document annual error statistics along with medication error types (wrong/unclear dose, wrong frequency, medication duplication) and hospital/center (Women's Specialized Hospital, Pharmacy Services Administration) and section/sub-unit (Outpatient Department, Maternity Ambulatory Pharmacy) information.

The researchers exported Datix data into a structured data format which they analyzed using IBM SPSS Statistics Version 28. The study utilized descriptive statistics to generate statistics about errors through frequency counts and percentage values for error categories such as hospital locations and section and subsections. Standard deviation,

minimum and maximum figures were calculated for the error counts of individual months (2013–2016), while the mean monthly counts for 2017 to 2023 were obtained by dividing annual totals by 12 because the incident date data were not available. The analysis based on inferential statistics used chi-square tests to detect distribution differences of error types and hospital/section levels between 2013 and 2023 while linear regression evaluated the error frequency changes through time with an $\alpha = 0.05$ significance level. The developed statistical techniques produced insights about substantial changes in error reporting patterns together with their relationship with EHRs system installations.

The research methodology provided a strong evaluation of EHRs system impacts on medication error reporting by utilizing standardized data sources with extensive variable investigations and advanced statistical procedures. These analytical methods generated reliable data about error pattern shifts while showing differences in error types between hospital departments and understanding the complicated links between electronic health record adoption and medical safety.

Results

Overview of Findings

This research studied medication error reporting at tertiary hospitals in Riyadh Saudi Arabia during an 11-year span (2013 to 2023) that followed the implementation of the EHRs system. Yearly incident report data of the hospital provided information about error frequencies also incorporating data about error types alongside hospital/center distributions and section/sub-unit data. The research used descriptive statistics alongside chi-square tests and linear regression for statistical analysis at $\alpha = 0.05$ to study temporal changes. The research supplies significant knowledge about how EHRs implementations affect medication error reporting through identification of emerging areas of progress and ongoing difficulties needing specific solutions. The analysis revealed three main trends coming from substantial error frequency variations while showing clear changes in reported error categories together with substantial variations among different hospital units which confirm the intricate role EHRs system plays in patient protection systems.

Descriptive Statistics

Total Medication Error Counts Per Year

Table 1 shows medication error totals that were reported from 2013 through 2023 along with the monthly average of medication errors which gives insight into error frequency variations during the study duration and provides evidence for how EHR implementation affected reporting patterns. The total medication error reports documented throughout the 11-

Table 1 Medication Errors from 2013 to 2023

Year	Total	Monthly Average
2013	2662	221.83
2014	1665	138.75
2015	725	60.42
2016	790	65.83
2017	871	72.58
2018	1742	145.17
2019	6108	509.00
2020	4166	347.17
2021	1210	100.83
2022	776	64.67
2023	1279	106.58

year period exhibited significant changes as shown in Table 1. The 6108 medication errors reported in 2019, which turned out to be an outlier, marked the maximum annual total which experts attribute to EHRs system changes and staff behavioral changes in that year. The 2015 data registered the system's minimum medication errors at 725 which might suggest that early adaptation issues due to unfamiliarity of new technology resulted in ascertainment limitations. The number of errors reduced significantly between 2013 and 2016 from 2662 to 790 that might be attributed to automated checks implemented in the EHRs system reducing mistakes. The substantial 2019 numbers leap from 1742 to 6108 indicates possible problems related to system usability difficulties and rising workloads or changes in reporting procedures forcing staff to document errors more extensively. Following 2019 there was another reduction in error counts which reached 1279 by 2023 potentially due to enhanced EHRs system features and reporting training programs. The patterns reveal the complex relationship between EHRs system deployment and healthcare staff adaptation as well as their influence on the reporting of identified errors which demands additional research on determining their real causes.

Monthly Average of Medication Errors Per Year

Figures 1 and 2 show the monthly average of medication errors (MAME) per year from 2013 to 2023, Medication Errors Trends and Best-fit Line. While there is an apparent fluctuating pattern in the MAME, aside from the years 2019 and 2020, there is a negative trend ($MAME = -6.06Year + 12331, R^2 = 17.0\%$) indicating a general decline between 2013 and 2023, which can possibly be attributed to the fact that the EHRs system implemented features such as automated alerts which improved documentation and standardized protocols. On the other hand, the vivid peak in 2019 (Figure 1) could be attributed to being in the COVID-19 pandemic era. The readiness status of health professions may have affected the sleep quality and hence the precision of their reporting.

Frequency of Error Types

As shown in Table 2 and Figure 3, the annual data show frequency of medication errors from 2013 to 2023. The errors stratified by type have been displayed with their corresponding numerical frequencies in an annual format throughout the study duration. The highest number of medication errors involved Wrong/unclear dose followed by Other, Wrong frequency, Medication duplication and Wrong drug/medicine. The highest number of "Wrong/unclear dose" errors reached 1307 in 2019 and this trend coincides with the total error count peak during that year possibly because reporting methods improved, or system documentation issues appeared with medication dosing. Both analyses revealed "Other" errors as significant segments which grew from 173 in 2023 but declined to 686 in 2019 while demonstrating a broad mixture of unidentified classification errors that future research should potentially explore through additional subgroup analysis. EHRs standardized protocols seem to contribute to reducing Wrong/unclear dose errors as these numbers decreased by 772 cases from 2013 to 2023. The EHRs

Figure 1 The monthly average of medication errors (MAME) per year from 2013 to 2023.

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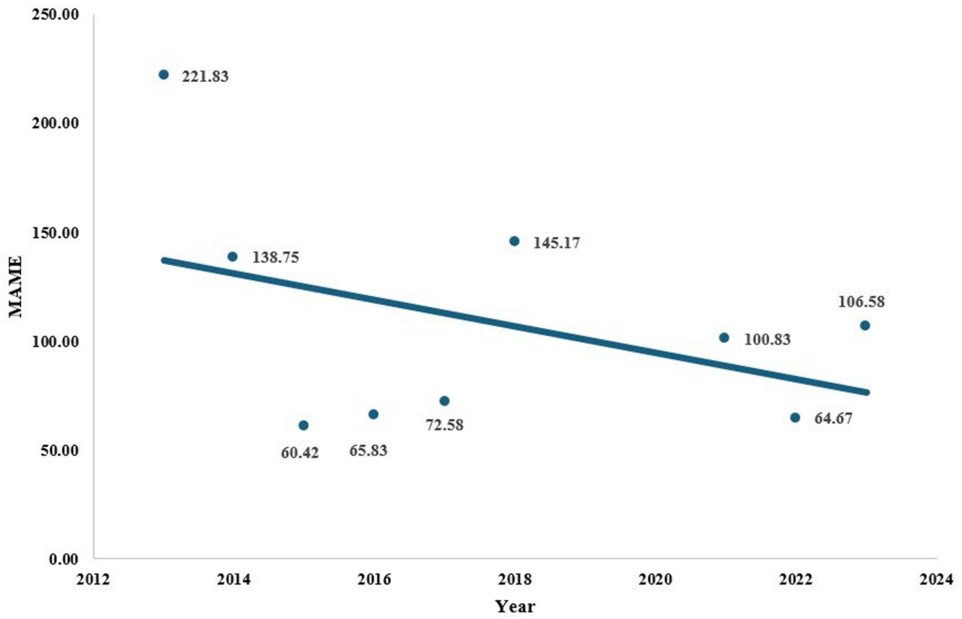

Figure 2 Monthly Average of Medication Errors (MAME) Trends and Best-fit Line. MAME = −6.0579Year + 12331; R^2 = 0.1696.

system may contribute to increased Medication duplication errors since these numbers grew by 297 possibly due to data entry mistakes that occur when using the medication duplication features of the system. Although the EHRs system succeeded in detecting specific errors, it prompted new error types which require ongoing training together with system optimization. The error distribution differed significantly between 2013 and 2023 based on a chi-square analysis with a test statistic of 1297.75 and a p-value < 0.001 at n = 3566. The substantial results show medication error patterns significantly shifted across the decade because EHRs system implemented alert systems and improved documentation tools together with new staff training protocols that heightened staff sensitivity to particular error frameworks.

Errors by Hospital, Center, or Administration

Table 3 shows how medication errors changed across different hospital areas from 2013 to 2023 pointing out locations with most error incidents for potential quality enhancement strategies. A comparative analysis of medication errors

Table 2 Frequency of Error Types (2013–2023)

Error Type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Communication problem	33	34	57	60	59	52	118	11	33	36	117
Compliance error	14	8	28	34	22	173	498	62	13	9	59
Medication Delivery Delay	115	12	123	13	76	82	234	17	80	29	93
Medication duplication	9	82	32	42	25	355	577	92	86	100	306
Medication unavailable	87	13	13	8	7	18	238	260	127	13	35
Wrong drug/medicine	250	123	86	101	126	122	268	55	88	44	67
Wrong frequency	194	99	101	126	50	134	675	450	69	26	48
Wrong route	72	54	11	10	17	17	103	86	7	10	9
Wrong/unclear dose	887	449	115	115	243	385	1307	1028	187	58	115
Wrong/unclear duration	276	143	14	9	34	109	199	25	37	78	9
Other	598	439	185	189	167	229	686	557	133	321	173

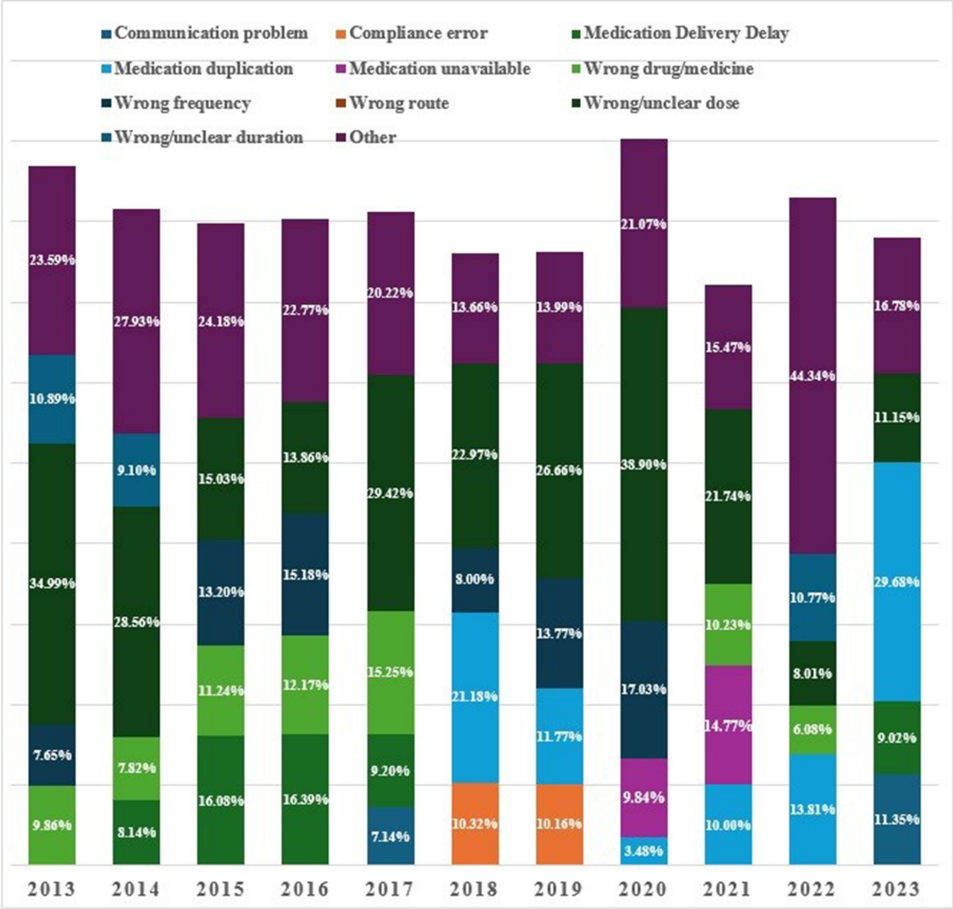

Figure 3 Evolving trends of the top five medicine errors across the study period.

between hospitals, centers, and administrations exist in Table 3 spanning 2013 to 2023. The 2013 annual records from Women's Specialized Hospital showed 1172 medication errors (44.0% of the total) with Children's Specialized Hospital registering 642 such mistakes (24.1%). Women's Specialized Hospital presumably experiences high medication errors due to complex medical situations or elevated patient numbers which affect obstetrics and gynecology care. The 2023 error statistics show a major change in results because Pharmacy Services Administration recorded 435 adverse errors

Table 3 Frequency of Errors by Hospital, Center, or Administration (2013 vs. 2023)

Hospital, Center, or Administration	2013 (n, %)	2023 (n, %)
Ancillary Services Administration	30 (1.1%)	0 (0.0%)
Anesthesiology & Perioperative Medicine Administration	0 (0.0%)	2 (0.2%)
Children's Specialized Hospital	642 (24.1%)	176 (13.8%)
Comprehensive Cancer Centre	81 (3.0%)	93 (7.3%)
Critical Care Nursing Administration	26 (1.0%)	40 (3.1%)
Critical Care Services Administration	1 (0.0%)	42 (3.3%)
E Business Administration	0 (0.0%)	4 (0.3%)
Emergency Medicine Administration	3 (0.1%)	127 (9.9%)

(*Continued*)

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Table 3 (Continued).

Hospital, Center, or Administration	2013 (n, %)	2023 (n, %)
Executive Assistant Director of Medical Affairs	2 (0.1%)	0 (0.0%)
Home Health Care Administration	0 (0.0%)	6 (0.5%)
Infrastructure Administration	0 (0.0%)	1 (0.1%)
Heart Centre	118 (4.4%)	28 (2.2%)
Main Hospital	416 (15.6%)	127 (9.9%)
Medical Imaging Administration	1 (0.0%)	0 (0.0%)
National Neuroscience Institute	65 (2.4%)	23 (1.8%)
Nursing Patient Relations, Ancillary & Support Services Administration	0 (0.0%)	1 (0.1%)
Obesity, Endocrine and Metabolic Centre	0 (0.0%)	1 (0.1%)
Operating Room Services Administration	1 (0.0%)	2 (0.2%)
Other Hospital	1 (0.0%)	0 (0.0%)
Outpatient Services Administration	0 (0.0%)	26 (2.0%)
Pharmacy Services Administration	75 (2.8%)	435 (34.0%)
Rehabilitation Hospital	28 (1.1%)	57 (4.5%)
Supply Chain (Logistics)	0 (0.0%)	6 (0.5%)
Women's Specialized Hospital	1172 (44.0%)	82 (6.4%)

while 2023 marked only 75 errors in 2013. The growing number of errors possibly indicates pharmacy plays a crucial role in EHRs medication dispensing thus enabling greater identification and reporting of dispensing inaccuracies. The number of errors in Women's Specialized Hospital decreased to 82 occurrences (6.4%) during 2023 possibly due to improved processes and targeted interventions or enhanced EHRs functionality in medication reconciliation. Child-specific care at Children's Specialized Hospital reported 176 errors amounting to 13.8% during 2023 when compared to 416 errors (15.6%) from 2013. The Main Hospital maintained its substantial error rate with 127 incidents totaling 9.9% in 2023 as opposed to 2013. The different clinical zones demonstrate varied EHRs system effects because some departments received better error detection abilities while others needed to adjust their workflows.

Data obtained through a chi-square test indicated that hospitals/centers demonstrated different error distribution patterns from 2013 to 2023 with values of χ^2 (23, n = 3941) = 1668.97, p-value < 0.001. The implementation of EHRs system produced variable effects between different medical centers because each center integrated systems differently and trained their personnel differently as well as deploying distinct clinical functionalities.

Errors by Section or Sub-Unit.

Top 5 Frequency of Errors by Section or Sub-Unit

Table 4 presents data regarding the leading five sections or sub-units by medication errors from 2013 and 2023. The Outpatients Department (Women's) recorded the maximum medication errors of 1154 (43.4% total) surpassing Outpatients Department (Peds) with 372 errors (14.0% of overall). The high number of medication errors in outpatient areas including women's departments and pediatric departments likely stems from the great amount of medication orders propelled in such settings where misstating dosages or duplicating prescriptions occur repeatedly. The Outpatients Department (Women's) and Outpatients Department (Peds) recorded significant error reduction leading to zero errors in 2023 which implies improved EHRs system functionality as well as trained staff reduced risks in problematic sections.

Maternity Ambulatory Pharmacy and Satellite Pharmacy sections showed new introduction of errors leading to 142 (11.1%) and 77 (6.0%) errors, respectively, during the 2023 assessment period. The number of reported errors in pharmacy-related sections increased in error logs because the EHRs system enhanced detection rates for dispensing errors. The number of medication errors at Central Unit Dose, Main Hospital increased substantially since 2013. The section reported 34 errors (1.3%) in 2013 yet disclosed 74 errors (5.8%) in 2023 as part of annual reporting. The data indicates that specific sections received positive impacts from EHRs deployment but specific errors in other sections need specific management methods for their correction.

Results from the chi-square test showed sections and sub-units displayed altered error distributions from 2013 to 2023 with χ^2 (179, n = 3938) = 3086.19 and p-value < 0.001. The EHRs system deployment created different effects on each section which might be caused by unique system interface characteristics and training implementation practices or workflow adjustment approaches within each area.

Frequency of Errors by Hospitals

The chi-square test results in Table 5 detail the distribution variations of errors between 2013 and 2023 in terms of hospital/center sections and sub-units and specific error types. Table 5 shows significant variations in error occurrences between 2013 and 2023 across numerous dimensions through chi-square tests. The chi-square value reaches 1297.75 (p-value < 0.001) to indicate a significant transformation in reported error types between 2013 and 2023. EHRs system features enhanced error detection for particular errors (wrong/unclear dose) yet established new issues (medication duplication). Hospitals/centers evaluation produced an exceptional chi-square outcome of 1668.97 (p-vale < 0.001) that indicates profound changes in error frequency particularly focused on Women's Specialized Hospital and Pharmacy Services Administration due to differences in centers' EHRs implementation and training. The sections/sub-units analysis demonstrated significant relationships through a chi-square value of 3086.19 (p-value < 0.001) because outpatient departments registered substantial reductions while pharmacy-related sections became newly vulnerable sections. This finding demonstrates why healthcare facilities require unique programs to remedy particular workflow problems found in multiple hospital sections while ongoing EHRs system monitoring ensures secure patient treatment.

Table 4 Top 5 Frequency of Errors by Section or Sub-Unit (2013 vs. 2023)

Section or Sub-Unit	2013 (n, %)	2023 (n, %)
Emergency Department (Adult)	119 (4.5%)	0 (0.0%)
Maternity Ambulatory Pharmacy	0 (0.0%)	142 (11.1%)
Outpatients Department	174 (6.5%)	0 (0.0%)
Outpatients Department (Peds)	372 (14.0%)	0 (0.0%)
Outpatients Department (Women's)	1154 (43.4%)	0 (0.0%)

Table 5 Chi-Square Test Results for Error Distributions (2013 vs. 2023)

Analysis	Chi-Square (χ^2)	p-value
Error Types (2013 vs. 2023)	1297.75	< 0.001*
Hospitals/Centers (2013 vs. 2023)	1668.97	< 0.001*
Sections/Sub-Units (2013 vs. 2023)	3086.19	< 0.001*

Note: *P-value is significant al level ≤ 0.05.

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Discussion

Based on the findings of this study at tertiary hospitals in Riyadh, Saudi Arabia, from the years 2013 to 2023, this study offers significant insights about the role of EHRs system components in Medication Error Reporting. The observed trends in error frequency and distributions in hospitals, center, subunit, section areas, and hospitals differ from existing literature but share certain traits, such as unique challenges and opportunities, in a major tertiary hospital. Using this prior research as a framework, these results are interpreted in this discussion and the implications for patient safety are evaluated, and directions for further improvement are suggested.

Overall, medication error counts varied greatly during the 11 years period studied: from 1279 errors in 2023 to 6108 errors in 2019. This general downward trend in error frequency from 2013 to 2023 mirrors work by Chimbo and Motsi (2024) demonstrating an effect of EHRs implementation on a drop in medication errors from greater documentation and automated alerts.[15] Bates et al (1998) found that EHRs system that include computerized physician order entry (CPOE), such as EHRs system, initially help reduce serious medication errors.[3] On the other hand, the sharp rise in 2019 may indicate an issue with that time period (such as system updates or change in reporting protocol) as noted by Gates et al (2021) who observed temporary increases in reported errors during the first EHRs implementation phase as staff acquired the systems.[7] The fact that this decline occurred and that error frequency seems to have been increased by EHRs support Naamneh and Bodas (2024) claims that EHRs lowered nurses' workload and increased accuracy in medication administration.[6]

The "Wrong/unclear dose" errors peaked in 2019 at 1307 but fell from 2013 to 2023 by 772 cases, whereas the numbers of "Medication duplication" errors rose 297 between the same periods. This finding is in line with the work of Carayon et al (2021) who stated that EHRs, good at minimizing error types like transcription and dispensing error, may actually introduce new types of errors resulting from EHRs system usability and data entry.[8] Second, the decrease in "Wrong/unclear dose" errors is congruent with the review of the literature of the ability of EHRs to reduce errors through the use of clinical decision support tools that prevent such occurrences as drug interactions or allergies.[8] Despite this, "Medication duplication" errors are increasing, which dampen the EHRs system design problem, as corroborated by Adams et al (2021) who find that usability issues such as complicated interfaces are factors leading to medication error.[11] The evidence of evolution in error types indicates that EHRs features that aid in identification of certain problems cause some errors to disappear while creating new error types that should be addressed specifically.

Results showed that hospitals/centers and sections/subunits confirmed that the distribution of errors was spread across hospitals, centers and sections/subunits in a significant number of cases. Osop and Sahama (2016) found that EHRs are important for improving clinical decision-making, which coincides with Women's Specialized Hospital's decline from 1172 errors (44.0%) in 2013 down to 82 (6.4%) in 2023.[16] In contrast, Pharmacy Services Administration errors increased by 75 (2.8%) to 435 (34.0%), which increase is likely due to increased reporting of dispensing errors as more errors are detected based on, where EHRs improve the accuracy of reported errors through standardized templates.[10] All the way down to the section level, the error decline rural (hospital Out Patient's Department (Women's) error falls from 10% to 0 in 2023) conforms with that literature review of the literature on EHRs' capacity to simplify the workflows for high volume areas.[7] New challenges, such as data overload, are possible explanation to the emergence of pharmacy related sections like Maternity Ambulatory Pharmacy (142 errors in 2023) as error prone areas.[12]

This supports some of the challenges in EHRs implementation referenced in the literature review and highlights usability and staff training. The rise in certain error types such as medication duplication may be explained because, among several issues including slow system response times, complex interfaces, and data overload, this is what may be responsible for the 2019 error peak.[11,12] Alzghaibi and Hutchings (2022) emphasize that these challenges suggest that although EHRs increase error detection, they also increase new risks that must be addressed by optimal system and training ongoing.[17] They are promising overall decline in error frequency but some of the errors (in pharmacy for instance) persist which means that they should do targeted interventions such as improve user interfaces and better training programs to reduce error rates further.[5]

Limitations and Future Research

Specific limitations of this study should be considered. Although we were able to retrieve large amount of data, a potential bias should be pronounced. Indeed, since secondary data were retrieved, we have no control on the data collection. In addition, in the results section, an assessment of variability in the reporting of error was not possible, due to the lack of monthly incident data from 2017 to 2023. Moreover, the cross-sectional design, despite the fact that it can identify trends, cannot establish causality. Longitudinal designs of future research should be employed to explore causal relationships between EHRs features and error rates. Qualitative studies with staff who use the EHRs system could uncover specific usability or workflow issues, which could be further pointed towards the 2019 error peak. The final part would consist of investigating the extent to which innovative EHRs tools, like artificial intelligence-based decision support, help prevent errors.

Conclusion

This study shows EHRs play a crucial role in reporting medication errors. As EHRs features such as automatic alerts and standardized protocols contributed to improved safety, therefore overall error frequency appears to have declined over time. EHRs can automatically alert healthcare providers to potential problems, such as drug-drug interactions, allergies, or duplicate therapies. In addition, standardized Protocols ensure that all providers follow evidence-based practices, reducing variation and minimizing the chance of prescribing errors. Error types changed quite a bit too, reducing "Wrong/unclear dose" errors but increasing "Medication duplication", which shows increased benefits and newly introduced risks associated with EHRs. The overall reduction in the error frequency supports the continued use of EHRs to increase patient safety. Decision-makers should consider standardized EHR training programs across hospitals to achieve consistent error reporting, error management, culture of safety, AI-assisted EHR, and real time error dashboards. Finally, EHRs system has greatly minimized medication errors in tertiary hospitals and improved patient safety through higher detection and reporting.

Data Sharing Statement

Data supporting the findings of this study are available on request from the corresponding author.

Ethical Approval

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (IRB) at King Abdullah International Medical Research Centre (KAIMRC). The study approval number is NRR24/029/6. The study does not require participant consent because it is a retrospective study of records. All data were fully anonymized before we accessed them.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report there are no conflicts of interest in this work.

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