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### RESEARCH ARTICLE

#### PREVALENCE AND TYPES OF MEDICATION ERRORS AT KING ABDULLAH SPECIALIZED CHILDREN HOSPITAL, RIYADH, SAUDI ARABIA.

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#### Key words:-

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#### Abstract

**Introduction:** Medication error is a serious medical concern defying the purpose of providing healthcare by causing harm and damage to the patient. The literature about medication errors in Saudi Arabia is lacking. The objective of this study is to estimate the prevalence of medication errors reported and identify their types, as well as to investigate the common factors contributing to their occurrence.

**Methods:** A chart-review study on all medication orders between April 2015 and January 2016 in King Abdullah Specialized Children Hospital (KASCH). Medication errors were categorized based on type of medication, location, specific event type, process stage at which the error has occurred and the contributing factors. Categorical variables were described as absolute frequencies and percentages. Multi-variant and Chi-square test were used to assess the relationship between certain variables.

**Results:** Of the 256,567 medication orders that were documented, 792 (0.31%) medication errors were reported. Patients between one and five years of age presented 207 (30%) cases. Majority of errors occurred in hospital wards 319 (40%), and pharmacy 167 (21%). Antibiotics 169 (22%), analgesic 75 (8%), and antineoplastic agents 75 (8%) were the most commonly involved medication. One-hundred sixty-five (21%) of the medication error reports involved high alert drugs. Of the medication error event types, dose-related errors were the most prevalent with 229 (29%) report. The majority of medication errors occurred during the prescribing/ordering stage with 367 (46%) report. Lack of quality control dominated the contributing factors to medication errors with 595 (75%) of incidents.

**Conclusion:** The rate of medication error reported in KASCH is lower than local and international rates. The implementation of Health Information System had a role in such low rate of medication error. Utilizing data in our study can further decrease medication error rate.

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## **Introduction:-**

Medication error is a serious medical concern defying the purpose of providing healthcare by inflicting harm and damage to the patient.<sup>1</sup> The initial alarming report came from the Institute of Medicine (IOM) in 1999 report “to Err is Human: Building a safer health system” showing that medication error related deaths are between 44 to 98 thousand per year in U.S, costing an estimated figure of 17 to 29 billion US Dollars and ranking as the most common type of errors in the health care system.<sup>2</sup>

It is important to mention that a medication error is not the same as an adverse drug reaction.<sup>3</sup> All stages of the medication utilization process (MUP) are prone to error, including packaging and nomenclature, product labeling, prescribing, order communication, dispensing, administration, monitoring, education, and use.<sup>4</sup> Error severity can range from no harm to death according to the classification by the National Coordinating Council for Medication Error Reporting and Prevention (*NCC MERP*), which had established criteria for severity of medication categorizing them by the letters A (no harm) to I (death).<sup>4</sup> By using these criteria, both medication misadventures that did not reach the patient (close call or near miss), hazardous environment that could lead to medication errors and omissions, which are the act of failing to do the right thing,<sup>5</sup> are all considered errors and should be reported as medication errors. A major US study done in 2003 revealed high levels of omission errors in the U.S. health care system and only about 55% of patients received high-quality care across all measures.<sup>6</sup>

Prevention of medication errors has become a mandatory process that requires system-wide improvements in many organizations.<sup>7</sup> The first strategy is by making the patients informed about their medication and involving them in the process to minimize chances of medication error.<sup>2</sup> Literature has supported the utilization of health information technology (HIT) to lower medication error rates and consequently enhance the quality of care. Electronic health records (EHRs) are one popular form for HIT that is commonly used. Recently, there have been an increasing number of hospitals and that are using EHRs across the globe.<sup>8</sup> EHRs are essential to improving patient safety.<sup>9</sup> A well-developed EHR can include variety of features that enhance medication safety and significantly reduce the rate of medication error through clinical decision support systems with computerized physician order entry (CPOE).<sup>7</sup> Computerized physician order entry implementation resulted in a significant decrease in serious medication error rates by 55% as reported in one of the landmark trial by Bates et al.<sup>10</sup> Furthermore, medication reconciliation is one of the methods that help in preventing medication errors<sup>11</sup>, EHR has made it easy to interface with the medication list and has made them electronically available for prescribers.<sup>12</sup>

These technologies have been proven to reduce medication errors in patients across all age groups, but perhaps the age group that will most benefit from implementing the technology are those most likely to be at risk of medication errors including the elderly and children. Medication errors in pediatric patients are common due to many reasons one of which is the need for high accuracy weight-based dose calculations further to the decimal points.<sup>13</sup> McPhillips et al reported that 15% of a 1933 randomly selected children who received new prescriptions had potential dosing errors and 33% of dosing errors occurred in children weighing less than 35 kg.<sup>14</sup> Aljeraisy et al found out that 56 out of every 100 medication orders in the general pediatric ward and pediatric intensive care unit (PICU) at King Abdulaziz Medical City had some error in them.<sup>15</sup>

The literature about medication errors in Saudi Arabia is lacking. The objective of this study was to estimate the prevalence of medication errors and identify their types as well as to investigate the common factors contributing to their occurrence at King Abdullah Specialized Children Hospital as hospital with a fully computerized healthcare system that includes all aspects of medical care from records and documentation to order entries.

## **Method:-**

### **Study design and settings:-**

This is a chart review based study of all medication orders for all patients of all age groups in King Abdullah Specialized Children Hospital (KASCH), Riyadh, Saudi Arabia between April 2015 and January 2016. KASCH is the first specialist Children’s Hospital in the Kingdom of Saudi Arabia with a capacity of 600 inpatient beds not including 60 beds for pediatric emergency and trauma unite, 50 beds for Pediatric Surgical and Medical Day Care and 70 beds in Chemotherapy and Hematology Infusion Area. KASCH is a paperless digital hospital with all patient files maintained in Health Information System known as BestCare system.

### **Study population, sample size and sampling technique:-**

By a consecutive sampling technique, the study included a total of 256,567 samples which represent all medication orders documented in KASCH BestCare System for all patients of all ages who were treated in general and specialized pediatric and adult wards, outpatient clinics, pediatric ER, pediatric High Dependence Unit, and Pediatric Intensive Care Unit in KASCH between April 2015 to January 2016. The Safety Reporting System (SRS) was used to extract all reported medication errors.

#### **Data collection and entry:-**

A data collection form was generated to collect extracted medication error reports and data from the electronic database. All variables such as demographics of the patient, drug name, high alert status of the medication, process stage of medication error, error type, location as well as the factors contributing to the error were collected.

#### **Data analysis:-**

A drug classification system was generated for all medication error reports based on drug names with the help of a PhD. clinical pharmacist to shorten possible answers.

Statistical Package for Social Sciences (SPSS, version 20; SPSS Inc.) was used for data analysis. The categorical variables were described as absolute frequencies and percentages such as gender, high alert status and drug class. Continuous data was summarized as mean and standard deviation such as age of the patient. Multi-variant and Chi-square test was used to assess the relation of high alert status location. All tests were considered significant when P value is less than 0.05.

#### **Ethical consideration:-**

Data collection and handling was done after taking permission from King Abdullah International Medical Research Center (KAIMRC) and the Institutional Review Board of King Abdullah International Medical Research Center. Confidentiality was insured and personal data was not and will not be revealed.

#### **Result:-**

##### **Overall prevalence and demographic characteristics of the patients:-**

This study included 256,567 medication orders that were documented in KASCH BestCare system between April 2015 and January 2016. Of these medication order records, 792 medication errors were reported in the Safety Reporting System (SRS) at a rate of one error per 324 medication orders, or 0.31%.

Male patients presented 51.3% of affected patients. Most patients were between one and five years of age presenting 207 (30.3%) cases and 122 (17.8%) cases involved patients under the age of one year. Majority of medication errors took place in hospital wards and pharmacies with 319 (40.3%) and 167 (21.1%) cases, respectively [Table 1].

No statistically significant difference was found between males and females in the rate of overall medication errors, HAME, drug classes, or in any specific medication error event type.

##### **Drug Class Involved:-**

Antibiotics ranked as the most commonly involved drugs in medication error reports by a significant margin with 196 (22%) cases, followed by analgesic and antineoplastic agents with 75 cases (8.4%) for each [Table 2]

Vancomycin was the most commonly reported antibiotic among antibiotic errors with 33 (17%) report, acetaminophen in analgesic agent errors with 38 (50.7%) report, Cytarabine & Etoposide in antineoplastic & chemotherapy errors with 10 (13.5%) report, Enoxaparin in anticoagulant errors with 11 (50%) report, prednisone in steroid errors with 4 (19%) report, and Medazolam in benzodiazepines errors with 4 (23.5%) reports as well.

##### **High alert medication errors prevalence (HAME) and location:-**

Of the medication error report, 165 (21%) involved high alert drugs, primarily antineoplastic and chemotherapy agents with 65 (39.4%) report, followed by high alert analgesic agents like morphine and fentanyl with 27 (16.4%) report, anticoagulants with 19 (11.5%) report and total parenteral nutrition (TPN) with 19 (11.5%) report.

Hospital wards had the highest incidence of HAME with 53 (32.1%) cases. However, it presented 16.6% of the total medication errors in the same location. Adult chemotherapy infusion unit had a total incidence of 19 (11.5%) HAME

cases. However, it presented 54.3% of the total medication error reports in the same location with a p-value of <0.001 [Table 3].

#### Types of Errors:-

Medication error specific event types ranged in frequency with dose-related errors being the most prevalent with 229 (28.9%) report, followed by medication-related errors (medication lost, incorrect, duplicated, package issue, and expired) with 211 (26.6%) report, and delay with 131 (16.6%) report [Table 4].

The most common forms of dose related errors were incorrect dose, extra/duplicated dose, and dose omission with 121 (15.3%), 46 (5.8%), and 30 (3.8%), respectively. As for the most common medication-related error forms, medication loss preceded with 84 (10.6%) report, followed by incorrect medication with 61 (7.7%) report, and medication packaging issues with 43 (5.4%) report [Table 4].

For the high alert medications event types, 41 (24.8%) report were dose related (incorrect, damaged, duplicated, wrong concentration or omitted), 33 (20%) report were delays and 19 (11.5%) report were incorrect medication. There were two incidents where high alert drugs were given to the wrong patient (TPN, letrozole) and one incident of narcotic drug loss [Table 5].

#### Medication process stages at which errors took place and contributing factors:-

The majority of medication errors took place in the prescribing/ordering stage with 367 (46.3%) report, dispensing in 253 (32%) report, and administering in 251 (31.7%) report [Table 6].

Lack of quality control dominated the factors contributing to medication error with 594 (75.2%) report, followed by the lack of staff education with 110 (13.9%) report, and drug storage and delivery with 59 (7.5%) report. Other contributing factors included miscommunication of drug order with 51 (6.5%) report, missing drug information with 50 (6.3%) report, and IT/ network problems 40 (5.1%) report [Table 7].

**Table 1:-** Demographics of the affected patients:

		N	%
Gender	Female	346	48.7%
	Male	364	51.3%
	Not specified	82	
Age group (17.7 + 23.3)	Less than one year	122	17.8%
	1 - 5	207	30.3%
	6 -14	164	24.0%
	15+	191	27.9%
	Not specified	108	
Location	Ward	319	40.3%
	Pharmacy	167	21.1%
	PICU/ICU	76	9.6%
	Clinic	67	8.5%
	HDU	60	7.6%
	ER	48	6.1%
	Adult infusion clinic	35	4.4%
	Other	20	1.6%
	<b>Total</b>	792	100%

**Table 2:-Drug Classes Involved in Medication Errors:**

Drug class	N	%
Antibiotic	196	22.0%
Analgesic	75	8.4%
Antineoplastic & chemotherapy	75	8.4%
Electrolyte	46	5.2%
Supplement	45	5.0%
Fluid	27	3.0%
Anticoagulant	22	2.5%
Anticonvulsant	22	2.5%
Steroid	21	2.4%
TPN	19	2.1%
Benzodiazepine	17	1.9%
Immunosuppressant	15	1.7%
Antiviral	14	1.6%
Antihypertensive	13	1.5%
Antifungal	12	1.3%
Miscellaneous	173	19.4%
Total	<b>792</b>	<b>100%</b>

**Table 3:-Frequency and Distribution of High Alert Medication Error (HAME) by Location:**

Location	N	Prevalence in location*	Prevalence overall**	P-value
Ward	53	16.6%	32.1%	<0.001
Pharmacy	38	22.8%	23.0%	
Adult chemotherapy Infusion Unit	19	54.3%	11.5%	
Clinic	19	28.4%	11.5%	
PICU/ICU	18	23.7%	10.9%	
HDU	12	20.0%	7.3%	
ER	2	4.2%	1.2%	
Other	4	30.8%	2.4%	
Total	<b>165</b>		<b>100.0%</b>	

\*HAME out of all medication errors in same location(HAME in location/all medication errors in same location).

\*\* High alert medication errors out of total number of HAME (HAME in location/total n of HAME).

**Table 4:-Specific Event Type For All Medication Errors:**

Specific Event Type		N	%
Dose-related errors	Dose incorrect	121	15.3%
	Dose extra/duplication	46	5.8%
	Dose omitted	30	3.8%
	Dose incorrect concentration/strength	20	2.5%
	Dose damaged/deteriorated	12	1.5%
Total		<b>229</b>	<b>28.9%</b>
Medication-related error	Medication-lost	84	10.6%
	Medication-incorrect	61	7.7%
	Medication-package issue	43	5.4%
	Duplicate therapy	15	1.9%
	Medication-expired/outdated	8	1.0%
Total		<b>211</b>	<b>26.6%</b>
Delay		131	16.6%
Frequency-incorrect		34	4.3%
Duration-incorrect		29	3.7%
Allergy-known-patient ordered/received medication		21	2.7%
Dosage form- incorrect		10	1.3%

Wrong Patient	10	1.3%
Incomplete Order	9	1.1%
Other	108	13.5%
Net total	<b>792</b>	<b>100.0%</b>

**Table 5:-Specific Event Types For High Alert Medication Errors (HAME):**

Specific event type for HAME		N	%
<b>Delay</b>		33	20%
<b>Dose related errors</b>	Dose incorrect	16	9.7%
	Dose omitted	9	5.5%
	Dose extra/duplication	7	4.2%
	Dose damaged/deteriorated	5	3%
	Dose incorrect concentration	4	2.4%
	<b>Total</b>	41	24.8%
<b>Medication-related errors</b>	Incorrect medication	18	10.9%
	Medication package issue	11	6.7%
	Medication duplication	4	2.4%
	Medication lost	10	6.1%
	Wrong patient	2	1.2%
	<b>total</b>	45	27.3%
<b>Patient received medication despite known allergy</b>		2	1.2%
<b>Incorrect frequency</b>		7	4.2%
<b>Incomplete order</b>		6	3.6%
<b>Medication discontinuation</b>		4	2.4%
<b>Narcotic broken</b>		4	2.4%
<b>Incorrect duration</b>		3	1.8%
<b>Dosage form incorrect</b>		3	1.8%
<b>Medication given without order</b>		1	0.6%
<b>Other</b>		16	9.7%
<b>Net total</b>		165	100%

**Table 6:-Medication process stages at which errors took place.**

Process stage	N	%
<b>Prescribing/ordering</b>	366	46.3%
<b>Administering</b>	251	31.7%
<b>Dispensing</b>	258	32.6%
<b>Storage</b>	97	12.3%
<b>Transcribing</b>	55	7%
<b>Monitoring</b>	35	4.4%
<b>Purchasing</b>	4	0.5%
<b>Patient Education</b>	5	0.6%

**Table 7:- Factors contributing to medication error**

Contributing factors	N	%
Lack of Quality Control	594	75.2%
Lack of Staff Education	110	13.9%
Drug Storage or Delivery	59	7.5%
Miscommunication of Drug Order	51	6.5%
Drug Information Missing	50	6.3%
IT/Network problems	40	5.1%
Others	71	9.0%

**Discussion:-**

In this study we measured the incidence of medication errors in KASCH and found out that to be 792 errors at rate of 0.31%. In a study conducted at an Australian children's hospital over a 4-year period, the reported overall medication error rate was the same as the rate reported in our study of 0.31%.<sup>16</sup> Al Jeraisy et al. reported the rate of medication errors to be 56 per 100 medication orders among inpatient pediatric in a tertiary care center in Saudi Arabia.<sup>15</sup> Similar high rates were reported for the pediatric population in Egypt, Iran, and West Ethiopia at 78%, 53%, and 75% respectively.<sup>18,19</sup> Ghaleb et al. reported 13.2% medication administration errors in the UK.<sup>20</sup> Aljadhy et al. found medication errors to be 32.36 per 100 medication orders among adult patients in four hospitals in Saudi Arabia.<sup>21</sup> The rate of prescribing medication errors in the Middle East ranged between 7.1% and 90.5% (lowest in Saudi Arabia, highest in Bahrain).<sup>19</sup> The rate of the errors reported in our study was low compared to rates in the United States, UK, and Pakistan, where the rates of reported medication errors were 6.9%, 3%, and 5.5%, respectively.<sup>22,23</sup> The rate, however, was similar to the rate reported by Alshaikh et al. at 0.4% in a hospital in Saudi Arabia.<sup>24</sup>

Prevalent types of medication errors were delay, incorrect dosage, and loss of medication. Most of medication errors occurred during the prescribing/ordering stage and the administering stage. According to a study done by Alsulami et al. that included 45 studies from the middle east, most common types of prescribing errors reported were incorrect dose (with an incidence rate from 0.15 % to 34.8 % of prescriptions), wrong frequency and wrong strength.<sup>19</sup>

Commonly involved drug classes were antibiotics, analgesics and antineoplastic agents which were similar to those reported by other studies.<sup>19,25</sup> Higher error report rates of high-alert medications is an indicator of better error surveillance.<sup>26</sup> Around one-fifth of the medication errors in this study involved high alert drugs, mostly antineoplastic agents, high alert analgesic agents, and anticoagulants.

The lack of quality control was found to be the most contributing factor in our study in around 75% of the cases followed by lack of staff education in around 14%. Miscommunication following patients' transfer across hospital facilities and the lack of following policies and procedures were the factors reported by Manias et al with incidence rate of 33.7% and 22.4%, respectively. Drug characteristics, administration time, heavy workload, and misinterpretation of the order were also suggested as contributing factors.<sup>16</sup>

Upon review of the literature we found that dose related errors constitute the majority of medication errors, which was also the case in our study.<sup>15, 16, 25,27</sup> This warrants implementation and evaluation of interventions aiming to eliminate these errors and maximize patient safety. MacKay et al demonstrated a decrease in dose-related medication errors in pediatrics by intravenous and oral medication standardization. This decreased workload, wastage, improved outcome, and lowered cost.<sup>28</sup> Barrier et al suggested standardizing the dosing instruments and units.<sup>29</sup> We recommended establishing measures to reduce dose related errors; their efficacy should be determined in further studies.

Finally, these lower rates of reported medication errors could raise the suspicion of underreporting which is a serious obstacle that needs to be addressed. However, this could have been the advantage of utilizing Computerized Physician Order Entry (CPOE) and pharmacist review of prescription as their implementation has shown to decrease medication errors by half.<sup>30, 31</sup> In Australia, 86% of adverse events related to medical errors, including medication errors, were not reported.<sup>32</sup> Mansouri et al. stated the barriers for underreporting to be personal fears, administrative barriers, and the reporting process.<sup>33</sup> Reasons for underreporting in the "Hospital incident reporting systems do not capture most patient harm" report were the absence of perceptible error, accustomedness to a common occurrence, expectation of side effects, and high frequency of occurrences.<sup>32</sup> Studies exploring underreporting causes in Saudi Arabia are needed.

**Limitations:-**

This study did not measure the prevalence of medication error in each and every specific location or department of the hospital. Some errors that did not inflict any serious harm on patients or alarm administration may have been underreported. The study did not include the medication error related patient-specific outcome.

**Conclusions:-**

In conclusion, Medication errors reported in King Abdullah Specialized Children Hospital, Riyadh, Saudi Arabia were less than the international figures. Most commonly involved drug classes were antibiotics, analgesics, and antineoplastic agents. Prevalent types of medication errors were delay, incorrect dose, and loss of medication. Most of the medication errors occurred during the prescribing/ordering stage and the administering stage. Utilizing data in our study to develop strategies that target contributing factors as well as the setting where medication error occur frequently could further decrease its rate. This study can serve as a benchmark to evaluate the progress of medication safety upon implementation of future strategies and measures.

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