


# Cost-effectiveness Analysis of Medication Safety Program at Pediatrics, Obstetrics and Gynecology Hospital, East Province, Saudi Arabia

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## ABSTRACT

**Objectives:** Medication safety program initiated at East Province of Ministry of Health in 2013. The pharmacist prevents all drug related problems. To improve continuity of care at hospital admission, discharge and to diminution medication errors medication safety programs are established. The objective of this study was to evaluate the cost-effectiveness of the Medication Safety program at the hospital in East province, Saudi Arabia by using International Study Model. **Methods:** This cross-sectional study with a 12-month recruitment period was conducted in a 500-bed Pediatrics, Obstetrics and Gynecology Hospital through preventing and documentation of medication errors in adults and pediatrics at Ministry of Health hospitals in 2015. The hospital had medication safety officer with medication safety committee. The program led by trained pharmacist and delivered basic patient safety in medical education to all healthcare professionals. The expected cost calculated using International Study Model, expressed in United State Dollars (USD), the cost measured were the expected results of medication errors outcome if not stopped; starting from ambulatory care visit or community pharmacy, additional laboratory test, hospital or critical care admission or even death complications. **Results:** The total number of prevented medication errors were 2071 at 827 prescribed to 827 patients with an estimated cost avoidance of avoiding medication was (116,228.41 USD) annually. The most estimated cost avoidance was prescriber related and general errors was 99.12% (115,201.9 USD). The pharmacist avoided medication errors with estimated cost avoidance of drug related problem (140.54 USD) per each prescription and (56.12 USD) per error. The most common categories of medications cost avoidance were Musculoskeletal and joint disease (8,397.2 USD) followed by Infections (5,731.17 USD) and Nutrition class (4,717.99 USD). The highest drug of cost avoidance were Insulin injection (39,964.32 USD), iron tablet (11,526.9 USD) folic acid tablet (11,526.9 USD) and calcium tablet (11,526.9 USD) and Enoxaparin injection (9,637.02 USD). There were three high-risk medication founded with Insulin, Enoxaparin and Heparin errors with (42.9%) of annual total cost avoidance. **Conclusion:** Medication safety program is a cost-efficiency replication at Pediatrics, Obstetrics and Gynecology Hospital in Saudi Arabia, prevents medication misadventures, improve patient safety and education. Growing drug safety program related with preventing drug-related problems and cost avoidance replication for Healthcare improvement, better care and better patient consequences.

**Key words:** Cost, Efficiency, Medication, Safety, Ministry of Health, Pediatrics, Obstetrics and Gynecology, Saudi Arabia.

## INTRODUCTION

The medication process is vulnerable and error prone as it is a composite five phase process: (a) prescribing, (b) verifying, (c) preparing/dispensing (d) administering and (e) monitoring.<sup>1</sup> Rates of medication errors vary, depending on the detection method used. Estimates of the occurrence of Medication Errors (MEs) vary between 5% and 25% of all medication administrations. The Error can be an error in drug selection, usage, dose, route of administration, quantity, indication or use in case of contraindication.<sup>2</sup> The national patient safety agency (NPSA) likewise recommend a wide range of different definitions in medication errors recording, together with techniques for information buildup. In-hospital medication preparation and administration has been considered as 'high risk' area. The complementary surely understood "six Rights of the Medication Use Process" ought to dependably be: patient, drug, dose, route, time and outcomes. Exclusion as well as failure to check individuality of patients, with

wrong administration technique or wrong dispensing or expired drug are considered administration errors.<sup>2</sup>

An instructive intercession program drove by the drug specialist was considered and connected.<sup>3</sup> The assessment method for such program was finished by recognizing level of errors after intervention and before.<sup>4</sup> Prescription errors have been characterized as "any preventable occasion that may cause or prompt wrong drug or patient damage under the supervision of the patient himself, a customer on his/her behalf or a health-care professional".<sup>5</sup> There are additionally extraordinary frameworks for arranging prescription errors. Health care quality problems may be classified into 3 categories, underuse, overuse and misuse, which affect patients' health and wellbeing. Underuse is the failure to provide a health care service when it would have produced a promising result for a patient. Overuse occurs when a health care service is provided under conditions in which its potential for injury exceeds

the possible advantage. Misuse occurs when an suitable service has been selected but a preventable complication occurs and the patient does not receive the full potential benefit of the service.<sup>6</sup> Adverse Drug Events (ADEs) in hospitalized patients will outcome in longer hospital stays and extra medical expenses, even though they are sometimes unnecessary. On the other side, another researcher has grouped prescription errors into 4 classes based on their potential clinical results:<sup>7</sup> type A (serious or potential seriousness); type B (significant annoyance drug specialist (either a pharmacist or a medical doctor) contact required); type C (minor disturbance - drug specialist must utilize proficient judgment); and type D which is called trivial.

The economics of medication safety program is seldom finding in the literatures especially in pediatrics population. Two international studies by Chen C *et al.*<sup>8</sup> and Najafzadeh M *et al.*<sup>9</sup> measured the economic impact and cost avoidance of the program. The studies showed the enhancement of the benefit-cost analysis from 4.29 to 9.36, total cost avoidance was 103,073,160 - 224,590,140 US \$ and average admission days decreased by 2 days after the on-ward deployment of a clinical pharmacist during the study period. Najafzadeh M *et al.* found 52% reduced of medication reconciliation discrepancies and total saved was 175,306 US \$ in the study period.<sup>9</sup> Despite times of effort to progress quality and safety in health care, this goal feels progressively indefinable. To the best of our knowledge, no comprehensive scientific study has explored these challenges and barriers in all Healthcare Facilities (HCFs) across the Kingdom of Saudi Arabia (KSA). The objective of this study was to evaluate the cost-effectiveness of the Medication Safety program at the hospital in East province, Saudi Arabia by using International Study Model.

## METHODS

This was a retrospective analysis of pharmacist intervention and prevented medication errors. This cross-sectional study with a 12-month recruitment period was conducted in a 500-bed Pediatrics, Obstetrics and Gynecology Hospital through preventing and documentation of medication errors in adults and pediatrics at Ministry of Health hospitals in 2015. The study included the hospital outpatient clinics and inpatient departments, ambulance as well as pharmaceutical preparation room, mixing intravenous solutions, all pediatrics and adults' patient during the conduct of the study. The routine work of an inpatient pharmacist consists of dispensing and reviewing medication orders. The hospital services cover a range of medical offerings from basic health care to Endocrinology Pediatrics, Hematology Pediatrics, Nephrology Pediatrics, Cardiology Pediatrics, Pulmonary Pediatrics, The Neonatal Intensive Care Unit (NICU), The Pediatric Intensive Care Unit, Obstetrics and Gynecology in addition to ambulatory care services and emergency services. Also, the hospital pharmacy offers very comprehensive pharmaceutical services including inpatient pharmacy, ambulatory care pharmacy, Total Parenteral Nutrition (TPN) services, drug information services and computerized physician order entry system inpatient and outpatient units. Also, the clinical pharmacist shared in the round with the medical team and patient counseling clinics. Medication safety program founded at East Province Region in 2013.<sup>10</sup> National medication safety program of Ministry of Health and Central committee of medication committee it headed by first and second authorship and East Province Regional Medication safety committee headed by second author. In particular, a hospital medication safety program managed by part-time pharmacist and the program consisted of medication officer and local committee of medication safety.

The officer monitors all medication errors, adverse drug reaction, drug quality system inside the hospital according to local standard of accreditation body (Saudi Central Board of Health Care Accreditation) standards and medication safety of Joint commission of Hospital accreditation from United States of America.<sup>11,12</sup> Beside, the implementations of the Institute Safety Medication Practice (ISMP) guidelines,<sup>13-16</sup> They also felt

accountable for medication safety course to all health care professional, physician, pharmacist, nurses etc. and report all medication safety related issues to higher administration and MOH.

Medication officers are responsible for documenting Medications Errors (MEs) and Adverse Drug Events (ADEs) using the different forms. All errors or unforeseen events related with the medication system or a step in the medication process shall be reported using the medication error notification form/medication error sheet whether or not the error reached the patient. The medical error form consists of 2 parts and 40 items including types and causes of medical errors. The form mainly consisted of patient information, description of errors - date and time, medical product involved in the event, impact of the error, consequences, intervention, the sources of medication errors and qualification of committing errors. Suspected medications, drug classification, stage of medication orders, details of reporter, route of administration for medication, the type of medication errors, description and causes of errors, agreement to prevent the errors and the significance of medication errors by using National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) system.<sup>17</sup> The expected cost calculated using International Study Model, expressed in USD, the cost measured were the expected results of medication errors outcome if not stopped; starting from ambulatory care visit or community pharmacy, additional laboratory test, hospital or critical care admission or even death complications.<sup>18,19</sup> The format analyzed through the Microsoft Excel Sheet Version 10<sup>th</sup>. The study was conducted according to the ethics guidelines set out in the Declaration of Helsinki and written consent from was obtained from the institution.

## RESULTS

The total number of prevented medication errors were 2071 at 827 prescribed to 827 patients with an estimated cost avoidance of avoiding medication was (116,228.41 USD) annually. The most estimated cost avoidance was prescriber related and general errors was 99.12% (115,201.9 USD), which include highly error in wrong abbreviation 86.27% (100,270.62 USD) and poor handwriting 12.63% (14,681.37 USD) (Table 1 and 2). The pharmacist avoided medication errors with estimated cost avoidance of drug related problem (140.54 USD) per each prescription and (56.12 USD) per error. The highest cost avoidance founded in old young adults (40 - 65 years) 20.81% (23,977.99 USD) and young adults (18-40 years) 11.90% (13,833.2 USD) (Table 2 and 3).

The most common categories of medications cost avoidance were Musculoskeletal and joint disease (8,397.2 USD) followed by Infections (5,731.17 USD) and Nutrition class (4,717.99 USD). The highest drug of cost avoidance was Insulin injection (39,964.32 USD), iron tablet (11,526.9 USD) folic acid tablet (11,526.9 USD) and calcium tablet

**Table 1: Type of medication errors vs documented cost avoidance.**

Type of Errors	Number	Cost (USD)	Percentages
Patient-Related error	426	0.00	0.00%
Prescriber-Related and general errors	1,633	115,201.90	99.12%
Drug-Related errors	9	705.25	0.61%
Dosage Form-Related Errors	0	0	0.00%
Therapeutics-Related Errors:	3	321.26	0.28%
Total cost	2,071	116,228.41	100.00%
Total cost with 10% discount		104,605.57	
Total cost with 20% discount		92,982.73	

**Table 2: The subtype of medication errors preventions vs documented cost avoidance.**

Subtype of medication errors	Number	Cost	Percentages
Patient-Related error			
Diagnosis not written	426	0	0.00%
Patient allergy	-	-	-
Patient body weight not written	-	-	-
Patient age not written	-	-	-
Wrong patient	-	-	-
Non- existing patient	-	-	-
Prescriber-Related and general errors			
Prescriber name is missing / unclear	-	-	-
Prescriber ID# is missing /unclear	-	-	-
Prescriber signature missing / unclear	-	-	-
Prescriber not follow policy of prescribing (write dose / weight)	4	219.56	0.19%
Wrong transcription	1	30.35	0.03%
Department is missing / unclear	-	-	-
Poor handwriting	561	14,681.37	12.63%
Wrong abbreviations	1067	100,270.62	86.27%
Prescription data unclear	-	-	-
Drug-Related errors			
Incorrect dose-overdosing	6	565.91	0.49%
Dose omitted	1	109	0.09%
Duration-inadequate	-	-	-
Dosing frequency-excessive	1	30.35	0.03%
Incorrect dose-under dosing	-	-	-
Amount of drug missing / unclear / insufficient	-	-	-
Drug name is missing /incorrect	-	-	-
Duration-excessive	-	-	-
Dosing frequency-inadequate	-	-	-
Incorrect drug	-	-	-
<b>Dosage Form-Related Errors</b>			
Incorrect /unclear formulation	-	-	-
Incorrect / unclear route	-	-	-
Incorrect / unclear strength	-	-	-
<b>Therapeutics-Related Errors</b>			
Drug-drug interaction	-	-	-
Drug-Disease interaction	-	-	-
Therapeutic duplication	2	60.7	0.05%
IV preparation without label	1	260.46	0.22%

(11,526.9 USD) and Enoxaparin injection (9,637.02 USD). There were three high-risk medication founded with Insulin, Enoxaparin and Heparin errors with (42.9%) of annual total cost avoidance (Table 4 and 5).

**Table 3: Age distribution vs documented cost avoidance.**

Answer Options	Response Count	Cost (USD)	Average cost per patient for each stage
30 Days	8	204.09	0.18%
1 month - 6 years	27	993.25	0.85%
6 - 12 years	35	2,544.78	2.19%
12 -18 years	27	1,188.9	1.02%
18- 40 years	158	13,833.2	11.90%
40 - 65 years	156	23,977.99	20.81%
more than 65 years	31	2,484.7	2.14%
<b>Answered question</b>	442		
<b>Skipped question</b>	363		

**Table 4: Medication classes vs documented cost avoidance.**

No	Medication classes	No of occurrences medication had errors	Cost avoidance (USD)
1	Musculoskeletal and joint disease	60	8,397.2
2	Infections	88	5,731.17
3	Nutrition	41	4,717.99
4	Gastrointestinal	37	1,782.6
5	Cardiovascular	44	1,295.44
6	Immunological products and vaccines	13	1,089.44
7	Malignant disease	7	240.62
8	Central nervous system	11	224.45
9	Endocrine system	9	254.8
10	Ear, Nose and oropharynx	2	56.52
11	urinary tract disorders	2	26.17
	Total	314	

## DISCUSSION

Although pharmacist-led medication reconciliation diminishes medication errors that commonly occur after hospital release, its economic value has not been entirely evaluated. In this study, we tried to evaluate cost-efficiency of medication safety program in pediatrics, obstetrics and gynecology hospital in East Province, Saudi Arabia. This is old method with new applications to detect, resolve, and prevent medication errors with medication-related problems.

The cost avoidance of medication safety program with emphasis on prevention of medication error was high and similar what reported by Chen C *et al.*<sup>8</sup> There were an average cost avoidance available in the literature due to different methods of cost calculations and the different estimated method of cost avoidance.<sup>9</sup> In the study, the most cost avoidance founded prescribing stage because the majority of medical errors were related to the prescribing stage (prescriber related medication errors). During this period, the hospital did not implement e-prescribing, drug altering system or clinical decision support system to prevent medication errors. As compared to handwritten prescriptions, computerized prescriptions seemed to be related with relatively lesser rates of error. This study estimated the cost avoidance of medication errors reported by pharmacists using an improved shared viewpoint. The medication safety

**Table 5: Top twenty medications involved prevention of errors VS documented cost avoidance.**

No	Medication	Cost
1	Insulin inj	39,964.32
2	Iron tab	11,526.9
3	Folic acid tab	11,526.9
4	Calcium tab	11,526.9
5	Enoxaparin inj	9,637.02
6	Normal saline drop	6,586.80
7	Paracetamol syp	5,757.4
8	Chlorpheniramine syp	4,448.9
9	Paracetamol supp	4,226.53
10	Oral rehydration solution	2,909.17
11	Amoxicillin/Clavulanic acid susp	2,381.47
12	Diphenhydramine syp	1,648.71
13	Cholecalciferol drop	933.13
14	Pseudoephedrine and Triprolidine syp	603.79
15	Gentamycin inj	424.93
16	Gentamycin eye drop	340.21
17	Heparin inj	260.46
18	Salbutamol Buff	219.56
19	Pipracillin/Tazobactam inj	218
20	Amoxicillin susp	183.19

pharmacist services have significant clinical benefits to patients and substantiate the greatest cost savings for healthcare budgets. Prevented errors were higher in patients with more ages because they used very critical and high-risk medications and any error, may be associated with an increased risk of hospitalization or permanent disability or critical admission or even death related complications.

The highest cost avoidance related class of medications was muscular and joint disease because the drug therapy of the disease had several complications especially for pain management for instant non-steroidal anti-inflammatory medications. The common types of error associated with antibiotics or antiviral medications were dosing related issues. The findings demonstrated that the highest drug of cost avoidance was Insulin injection, iron, calcium and folic acid tablet (maternity cases) and Enoxaparin injection. Another highest class of medications in cost avoiding of prevention medications errors in pediatrics populations was nutrition medications like Total Parenteral Nutrition (TPN) similar to previous study reported by Alomi YA *et al.*<sup>20</sup> Some high-risk medications occurred during committing errors in current study for insulin or heparin because their complications and economic burden are high.

The most of findings of current research were problematic to compare with other investigations because rarely existed of research variables and to the best of our knowledge, there is no study relating to this. The economic impact is very high in the study and the expanding pharmacist role is essential to include all drug distribution system in the hospital. Studies have constantly established that pharmacists contribute to reductions in costs in a wide variety of healthcare surroundings. The healthcare insurance companies should utilized the pharmacy to avoid un-necessary economic burden on healthcare system with implementation of new vision 2030.<sup>21</sup> Factors other than the intervention cost might limit the execution of medication reconciliation. The clinical Pharmacist or

distributive pharmacist showing this intervention must have access to precise and timely information about inpatient and outpatient medications. Most of the patient's viewpoint, results of complications of drug-related problems resemble what published in the other investigations with different practice.

## CONCLUSION

Medication safety program is a cost-efficiency replication at Pediatrics and Obstetrics and Gynecology Hospital in Saudi Arabia, prevents medication misadventures, improve patient safety. Increasing drug safety program associated with preventing drug-related problems and cost avoidance replication for Healthcare improvement, better care and better patient consequences. High-quality economic evaluations with healthy methodologies and study design are required to explore what pharmacist services have noteworthy clinical benefits to patients and verify the greatest cost savings for healthcare budgets.

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None.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ABBREVIATIONS

**MEs:** Medication Errors; **ADRs:** Adverse Drug Reactions; **NPSA:** National Patient Safety Agency; **NICU:** Neonatal Intensive Care Unit; **TPN:** Total Parenteral Nutrition; **MOH:** Ministry of Health; **ISMP:** Institute Safety Medication Practice; **NCC:** National Coordinating Council; **MERP:** Medication Error Reporting and Prevention; **KSA:** Kingdom of Saudi Arabia; **USD:** United State Dollars.

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