

Cost Analysis of Clinical Compounding in Saudi Arabia: Autoimmune and Gastrointestinal Pediatric Formulations

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ABSTRACT

Objectives: To explore the cost analysis of selected autoimmune and gastrointestinal pediatric formulations in Riyadh city, Saudi Arabia. **Methods:** This is a retrospective cost analysis study of autoimmune and gastrointestinal pediatric formulations at a pediatrics and maternity hospital in Riyadh city, Saudi Arabia. The extemporaneous pharmacy section regularly receive prescriptions with specific formulation from physician. The expert pharmacist applies the international standard of clinical compounding for all pediatric formulation related issue over 8 hr per days for 5 days per a week. The pediatric formulations consisted selected autoimmune and gastrointestinal medications. The cost analysis includes variable expenses such as personal cost, material cost and supply cost and fixed costs includes direct cost, non-salary cost and overhead cost. All costs were derived from the Ministry of Health information database. All costs were considered based on US dollar currency. In this study, we analyzed the cost of autoimmune and gastrointestinal pediatric formulations through the use of Microsoft Excel software version 10. **Results:** The estimated average total standard cost of pediatric formulations per hour was (53.82 USD). The average estimated cost of hydrocortisone per preparation was (12.896 USD). The total annual cost of hydrocortisone was (1547.52 USD). The average estimated cost of prednisolone per preparation was (4.6 USD). The average estimated cost of allopurinol per preparation was (6.99 USD) and the average estimated cost of sildenafil per preparation was (25.05 USD). The average estimated cost of omeprazole per each one preparation was (24.07 USD) and the total annual cost of omeprazole was (7221 USD). The average estimated cost of ranitidine per preparation was (5.248 USD) and the total annual cost of ranitidine was (2760.45 USD). The average estimated cost of baclofen per preparation was (21.266 USD) and the total annual cost of baclofen was (7655.76 USD). **Conclusion:** Based on the cost analysis, the cost of selected pediatric autoimmune and gastrointestinal pediatric formulations were higher than the ready-made products manufactured by pharmaceutical companies. The pharmacist should select the cheapest one among them. The cost analysis of pediatric formulation can be used to cover health insurance and meet the updated pharmacy strategic plan and New Saudi Vision 2030 in the Kingdom of Saudi Arabia.

Key words: Cost, Clinical, Compounding, Autoimmune, Gastrointestinal, Pediatrics, Formulations, Ministry of Health, Saudi Arabia.

INTRODUCTION

The New Saudi Vision 2030 was released in 2016 with an updated healthcare strategic plan at the Ministry of Health (MOH) in the Kingdom of Saudi Arabia (KSA). Subsequently, the updated pharmacy strategic plan was based on the New Saudi Vision in 2017.^[1] The plan consisted of five strategic goals including healthcare, economic and pharmacoeconomic sections. The cost analysis of all adults and pediatric diseases and their management was part of the plan including the health insurance coverage.^[1] Moreover, the cost analysis needed to calculate the economic burden and impact of pharmacy services. All pediatric diseases, including medical and surgical care require medications, for instance, asthma, allergy, peptic or gastric ulcer, pediatric gout, pulmonary hypertension and pediatric trauma. The different medications include hydrocortisone, prednisone, ranitidine and baclofen. Most of the previous medications were available as oral tablets or capsules^[2-5] Several textbooks discussed the

conversion from adults dosage form to pediatric formulations syrup or suspension for neonates and pediatrics.^[6] Moreover, not all pediatric formulations are available in the local or international market.^[2-5] Moreover, it is essential to conduct cost analysis of pediatric formulations for calculation pharmacy budget with the income and expenses of the medications. Several publications have shown the cost analysis of pharmacy services but not pediatric formulations.^[7-10] The authors are not familiar with any investigation in Saudi Arabia, Gulf, or Middle Eastern countries about cost analysis of pediatric formulation of the previous diseases.^[2-5] Therefore, the aim of this study was to explore the cost analysis of selected pediatric formulations of certain diseases in pediatric populations in the KSA.

METHODS

This is a retrospective study of cost analysis of drug information services past 1 year at pediatrics

and maternity hospital in Riyadh city, Saudi Arabia. It has inpatient admission, ambulatory care clinics and emergency departments. The hospital has a different specialty for women and pediatrics. The hospital take care of the common neonatal, pediatrics and women health disease. The hospital has pharmacy service, inpatient pharmacy with unit dose drug distribution system, outpatient pharmacy and extensive extemporaneous pediatric section and drug information center. The pharmacy follows computerized physician order entry system with an electronic prescription in addition to the pharmacy medications safety program. The pharmacy conducts training on clinical and pharmacy programs. The extemporaneous section has very comprehensive pediatric formulations for neonates and pediatrics in the central region of MOH hospitals. The extemporaneous pharmacy section receives the prescriptions of specific formulation from physician. The expert pharmacist prepare the pediatrics formulation according to the international standard of clinical compounding over 8 hr per days for 5 days per a week. The pediatric formulations consisted of antibiotics, anti-tuberculosis medications, anticonvulsant medications and gastrointestinal (GI) drugs, anti-hypertensive medications, electrolyte supplements, renal preparations, diuretic formulation, steroid preparations and other supportive formulations. The cost analysis included variable expenses such as personal cost, material cost and supply cost and fixed costs includes direct cost, non-salary cost and overhead cost.^[8,9] In addition to the cost of compounding substances, number of preparations and time spend of preparations were calculated. All costs were derived from the MOH drug information database. All costs were calculated based on US dollar currency. In this study, we analyzed the pediatric antibiotic formulations through the use of Microsoft Excel software version 10.

RESULTS

The estimated average total standard cost of pediatric formulations per hour was 53.82 USD and consisted of 58.58% (31.53 USD) personal cost, 25.14% (13.53 USD) overhead cost, 3.34% (1.8 USD) material and supply cost and 12.93% (6.96 USD) nonsalary cost (Table 1). The average estimated cost of hydrocortisone per preparation was 12.896 USD which consisted of standard cost (0.336 USD) and direct cost (12.56 USD). The total annual cost of hydrocortisone was 1547.52 USD (Table 2). The average estimated cost of prednisolone per preparation was 4.6 USD which consisted of standard cost (0.28 USD) and direct cost (4.32 USD). The total annual cost of prednisolone was 575 USD (Table 3). The average estimated

cost of allopurinol per preparation was 6.99 USD which consisted of standard cost (4.03 USD) and direct cost (2.96 USD). The total annual cost of allopurinol was 69.9 USD (Table 4). The average estimated cost of sildenafil per preparation was 25.05 USD which consisted of standard cost (5.38 USD) and direct cost (20.78 USD). The total annual cost of sildenafil was 250.5 USD (Table 5). The average estimated cost of omeprazole per preparation was 24.07 USD which consisted of standard cost (0.179 USD) and direct cost (23.89 USD). The total annual cost of omeprazole was 7221 USD (Table 6). The average estimated cost of ranitidine per preparation was 5.248 USD which consisted of standard cost (0.038 USD) and direct cost (5.21 USD). The total annual cost of ranitidine was 2760.45 USD (Table 7). The average estimated cost of baclofen per preparation was 21.266 USD which consisted of standard cost (0.056 USD) and direct cost (21.21 USD). The total annual cost of baclofen was 7655.76 USD (Table 8).

DISCUSSION

The pediatric formulations were divided into several pharmacological groups at the extemporaneous unit of the local study pharmacy site, such as anti-hypertension pediatric formulations, antibiotic pediatric formulation and renal pediatric medications.^[6] Some pediatric formulations were noncategorized. In this study, we explored the cost analysis of selected autoimmune, gastrointestinal and miscellaneous pediatric formulations. All pediatric formulations had same essential indirect cost. The majority of the direct cost came from personal cost because all the preparations needed pharmacy personnel without the need of any specialized equipment or materials. In this study, two types of steroid medications were assessed: hydrocortisone and prednisone. Hydrocortisone was more expensive than that of prednisone, which is due to the direct cost of material and less of production of hydrocortisone. Prednisone is much cheaper in Saudi Arabia than that of USA and UK.^[2] The product should be obtained from the local market. The hydrocortisone syrup is not registered at KSA, USA and UK (Table 7).^[2-5] The pharmacist should prepare hydrocortisone syrup in the pharmacy when required. Our results showed that two anti-ulcer medications (omeprazole and ranitidine) were more expensive, which is due to material cost. Moreover, both anti-ulcer medications showed that the direct cost was higher than indirect cost because of higher production cost. The cost of ranitidine syrup almost similar the cost of registered product in KSA and much cheaper than USA and UK (Table 7).^[2-5] The ranitidine

Table 1: Standard cost analysis of pediatric formulations (USD).

	Cost per hour
Personal	
Head compounding pharmacist	27.27
staff compounding pharmacist	4.26
Total	31.53
Over Head cost	
Rent	0
Bed	0
Offices	0.46
Chairs	1.54
Computer	0.68
Printer	1.43
Zebra label printer (Direct Thermal)	3.08
Refrigerator	1.66
Balance	0.17
Beakers	0.14
Stainless steel spoon	0.21
Measuring cup	0.25
Measuring Cylinder	0.15
Silicone spoon	0.05
cooker	0.03
Funnel	0.04
Bunchner	0.05
Test tube brush	0.04
Kettle	0.15
Mortar and Pestle	0.11
Glass rode	0.02
Shelf	3.23
Pen/pencils	0.04
scissors	0.02
Total	13.53
Material and supply	
Large	0.65
Amber bottle	0.21
Syringe	0.12
gloves	0.49
Blue sheet	0.31
Face mask	0.02
Total	1.8
Non Salary cost	
Education and Training head	6.61
Education and Training staff	0.34
Total	6.96

Table 2: Cost of hydrocortisone 1 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 45 min per one bottle	40.365
Total of preparation 120 per year, the cost per one 100 ml	0.336
Direct cost	
Hydrocortisone 10mg = 10 tab	0.83
Oral Plus= 50 ml	5.87
Oral Sweet to 100 ml	5.87
Total	12.56
Grand Total 100 ml per bottle	12.896
Annual Grand Total cost	1,547.52
References	
1. Fawcett JP, Boulton DW, Jiang R, Woods DJ, Stability of Hydrocortisone Oral suspensions prepared from Tablets and Powder. <i>Annals of pharmacotherapy</i> , 1995;29(Oct):987-90.	
2. Jackson M, Lowey A. <i>Handbook of Extemporaneous Preparation</i> . Pharmaceutical Press. 2010; 1-235	

Table 4: Cost of allopurinol 20 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 45 min per one bottle	40.365
Total of preparation when needed (around 10) per year, the cost per one 100 ml	4.03
Direct cost	
Allopurinol 100mg= 20 tablet	2.08
Universal vehicle to 100 ml	0.88
Total	2.96
Grand Total 100 ml per bottle	6.99
Annual Grand Total cost	69.9
References	
1. M. Haq ABS, Mohd Din RB, Othman NB, <i>et al.</i> Extemporaneous Formulation. Pharmaceutical Services Division. Ministry of Health Malaysia. 2015	
2. Jew RK, Erush SC, Soo-Hoo W, Amiri E. Extemporaneous Formulation for pediatrics, geriatrics and special needs patients. 2016. 3 rd edition. American Society of Health-System Pharmacists, Inc.	

Table 3: Cost of prednisolone 1 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 40 min per one bottle	35.51
Total of preparation 125 per year, the cost per one 100 ml	0.28
Direct cost	
Prednisolone 2mg= 20 tab	1.65
Simple syrup to 100 ml	2.67
Total	4.32
Grand Total 100 ml per bottle	4.6
Annual Grand Total cost	575
References	
Jew RK, Erush SC, Soo-Hoo W, Amiri E. Extemporaneous Formulation for pediatrics, geriatrics and special needs patients. 2016. 3 rd edition. American Society of Health-System Pharmacists, Inc.	

Table 5: Cost of sildenafil 2.5 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 60 min per one bottle	53.82
Total of preparation when needed (around 10) per year, the cost per one 80 ml	5.38
Direct cost	
Sildenafil 50mg = 4 tab	19.67
methylcellulose 1%	0.05
Simple syrup to 80 ml	1.07
Total	20.78
Grand Total 80 ml per bottle	25.05
Annual Grand Total cost	250.5
References	
1. M. Haq ABS, Mohd Din RB, Othman NB, <i>et al.</i> Extemporaneous Formulation. Pharmaceutical Services Division. Ministry of Health Malaysia. 2015	
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syrup should be obtained from the local market, whereas omeprazole pediatric formulation is not registered in the KSA, USA and UK.^[2-5] The pharmacist should prepare the product when needed. Our results showed that allo-

purinol has indirect cost higher than direct cost because the number of preparations was a few preparations annually, it may lead higher cost per each preparation. Allopurinol pediatric formulation has not been registered in the

KSA, USA and UK (Table 7).^[2-5] The pharmacist should prepare the product when needed. In sildenafil, direct cost was higher than that of the indirect cost which is related to the cost of the raw material which was expensive although

Table 6: Cost of omeprazole 2 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 60 min per one bottle	53.82
Total of preparation 300 per year, the cost per one 200 ml	0.179
Direct cost	
Omeprazole 20mg = 20 cap	19.63
Sodium Bicarbonate 8.4% to 200 ml	4.27
Total	23.89
Grand Total 200 ml per bottle	24.07
Annual Grand Total cost	7,221

References

1. Quercia RA, Chengde F, Xinchun L, *et al.* Stability of Omeprazole in an Extemporaneously prepared Oral Liquid. Am J Health-Systs Pharm, 1997; 54:1833-6.
2. Jackson M, Lowey A. Handbook of Extemporaneous Preparation. Pharmaceutical Press. 2010; 1-235

Table 8: Cost of baclofen 5 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 22.5 min per one bottle	20.18
Total of preparation 360 per year, the cost per one 120 ml	0.056
Direct cost	
Baclofen 10mg = 60 tab	17.92
Glycerol = 4 ml	0.09
Simple syrup to 120 ml	3.20
Total	21.21
Grand Total 120 ml per bottle	21.266
Annual Grand Total cost	7,655.76

References

1. Johnson C.E., Hart S.M. Stability of an Extemporaneously Compounded Oral Liquids. Am J Hosp Pharm. 1993;50:2353-55 .
2. M. Haq ABS, Mohd Din RB, Othman NB, *et al.* Extemporaneous Formulation. Pharmaceutical Services Division. Ministry of Health Malaysia. 2015

Table 7: Cost of ranitidine 15 mg/mL (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 22.5 min per one bottle	20.18
Total of preparation 526 per year, the cost per one 100 ml	0.038
Direct cost	
Ranitidine 150mg = 10 tab	3.87
Simple Syrup 50 ml	1.33
Dist. Water to 100 ml	0.01
Total	5.21
Grand Total 100 ml per bottle	5.248
Annual Grand Total cost	2,760.45

References

1. Kames HT, Harris SR, Gamett WR, March C. Concentration uniformity of extemporaneously prepared ranitidine suspension. Am J Health-Systs Pharm, 1989; 46(2):304-307.
2. Jew RK, Erush SC, Soo-Hoo W, Amiri E. Extemporaneous Formulation for pediatrics, geriatrics and special needs patients. 2016. 3rd edition. American Society of Health-System Pharmacists, Inc.

the number of preparations was low. Sildenafil pediatric formulation is not registered in the KSA, USA and UK (Table 7).^[2-5] The pharmacist should prepare the product when needed. In the case of baclofen, our results showed that the direct cost was higher than the indirect cost, which is due to material cost and number of preparations annually were high and may lead to reduction in the indirect cost. Baclofen pediatric formulation is not registered in the KSA, USA and UK (Table 7).^[2-5] The pharmacist should prepare the product when required. The highest cost consumption of pediatric formulations was related to baclofen, omeprazole and ranitidine, which is due to the cost of the raw materials, which was expensive and a high number of products. The cost analysis of selected autoimmune, gastrointestinal and miscellaneous pediatric formulations were necessary to setup selling cost and health-care insurance coverage in the future, which is required by the New Saudi Vision 2030.^[1]

CONCLUSION

Most of the immunosuppressive agents or gastrointestinal medications dosage forms are available in the local or international market for adult population. However, the pediatric formulations of these products are not commonly found in the market. The extemporaneous preparations with cost analysis are part of pharmacy strategic plan with New Saudi Vision 2030. Annually or once in every 2 years cost

analysis of rarely used pediatric immunosuppressive agents or gastrointestinal medications is required in order to develop pharmacy budget and pharmacoeconomic implementation in the KSA.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

SFDA: Saudi Food and Drug Authority; **WHO:** World Health Organization; **KSA:** Kingdom of Saudi Arabia; **USD:** United State Dollars; **GI:** gastrointestinal; **GERD:** Gastroesophageal reflux diseases; **MOH:** Ministry of Health; **TB:** tuberculosis; **USA:** United States of America; **UK:** United Kingdom.

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Table 9: The cost analysis of autoimmune and gastrointestinal pediatric formulations.

Medications name	Cost of Current study		Cost in SA (USD) ^[2]		Cost in US (USD) ^[3]		Cost in UK (USD) ^[4,5]	
	Conc. mg/ml	Volume	Conc. mg/ml	Volume	Conc. mg/ml	Volume	Conc. mg/ml	Volume
Hydrocortisone 1mg/1ml	1mg/ml = 0.1289 \$	100 ml= 12.896 \$	Non available	Non available	Non available	Non available	Non available	Non available
Prednisolone 1mg/1ml	1mg/ml = 0.046 \$	100 ml= 4.6 \$	1mg/ml = 0.031 \$	3 mg/ml 120 ml = 11.2 \$ (100 ml = 9.33 \$)	1mg/ml = 0.0285 \$	15 mg/ml 50 ml = 21.39 \$ 50 ml = 42.5 \$ (100 ml = 42.78 \$) (100 ml = 85 \$)	1mg/ml = 0.23 \$	10 mg/ml 30 ml = 69.26 \$ (100 ml = 230.86 \$)
			1mg/ml = 0.0533 \$	1 mg/ml 100 ml = 5.33 \$	1mg/ml = 0.0566 \$			
			1mg/ml = 0.028 \$	3 mg/ml 120 ml = 10.08 \$ (100 ml = 8.4 \$)				
			1mg/ml = 0.037 \$	1 mg/ml 120 ml = 4.45 \$ (100 ml = 3.7 \$)				
Allopurinol 20mg/1ml	1mg/ml = 0.00035 \$	100 ml= 6.99 \$	Non available	Non available	Non available	Non available	Non available	Non available
Sildenafil 2.5mg/1ml	1mg/ml = 0.125 \$	80 ml= 25.05 \$ (100 ml= 31.312 \$)	Non available	Non available	Non available	Non available	Non available	Non available
Omeprazole 2mg/1ml	1mg/ml = 0.6.01 \$	200 ml= 24.07 \$ (100 ml= 12.035 \$)	Non available	Non available	Non available	Non available	Non available	Non available
Ranitidine 15mg/1ml	1mg/ml = 0.00035 \$	100 ml= 5.248 \$	1mg/ml = 0.0040 \$	15 mg/ml 150 ml = 9.12 \$ (100 ml = 6.08 \$)	1mg/ml = 0.00925 \$	15 mg/ml 60 ml = 8.33 \$ (100 ml = 13.88 \$)	1mg/ml = 0.0060 \$	15 mg/ml 300 ml = 27.14 \$ (100 ml = 9.046 \$)
Baclofen 5mg/1ml	1mg/ml = 0.035 \$	120 ml= 21.266 \$ (100 ml= 17.721 \$)	Non available	Non available	Non available	Non available	1mg/ml = 0.0564 \$	1mg/ml 300 ml = 16.94 \$ (100 ml = 5.646 \$)

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