Cost Analysis of Clinical Compounding in Saudi Arabia: Oral Electrolyte Pediatrics Formulations

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ABSTRACT

Objectives: To explore cost analysis of selected oral electrolytes pediatrics formulations in the Kingdom Saudi Arabia. **Methods:** It is a retrospective cost analysis of pediatrics formulations at 300-beds pediatrics and maternity hospital in Riyadh city, Saudi Arabia. The pharmacy section received the specific formulation from physician then the expert pharmacist applied the international standard of clinical compounding through of providing to healthcare staff over eight hours per days for five days per a week. The pediatrics formulations consisted selected four selected electrolytes. The analysis of the cost was included the variable expenses like personal cost, material and supply cost. Fixed costs include direct cost, non-salary cost and overhead cost. The cost was derived from the Ministry of Health information database. All cost was used US dollar currency. This study analyzed the cost of anti-hypertension pediatrics formulations through the Microsoft Excel sheet version 10th. **Results:** The estimated average total standard cost of pediatrics formulations per hour was (53.82 USD). The average estimated cost of potassium chloride 10% per each preparation was (2.053 USD) and the total annual cost of potassium Chloride 10% was (172.452 USD). The average estimated cost of potassium chloride 7.5% per each preparation was (1.342 USD) with the total annual cost of potassium chloride 7.5% was (228.14 USD). The average estimated cost of sodium bicarbonate 8.4% per each preparation was (0.7551 USD) with the total annual cost of sodium bicarbonate 8.4% was (54.36 USD). The average estimated cost of calcium carbonate 200 mg/mL per each preparation was (5.45 USD) with the total annual cost of calcium carbonate 200mg/mL was (1,046.4 USD). The average estimated cost of sodium chloride 5.8% per each preparation was (1.117 USD) which the total annual cost of sodium chloride 5.8% was (167.55 USD). **Conclusion:** Most the electrolyte pediatrics formulations which are not available in the local or international market. Pharmacists should continue to prepare them with lower economic burden. The study was first done in KSA and meet new health strategic plan of Saudi vision 2030 in the Kingdom of Saudi Arabia.

Key word: Cost, Clinical, Compounding, Electrolyte, Pediatrics, Formulations, Ministry of Health, Saudi Arabia.

INTRODUCTION

The national pharmacy nutrition support program was established as part of the Pharmacy strategic plan.[1,2] The program consisted of several elements neonatal parenteral nutrition, parenteral pediatrics nutrition, adults' parental nutrition, home total parental nutrition for adults, pediatrics and neonates,[3] in addition to enteral feeding for all types of populations. During Total Parenteral Nutrition (TPN) administration for chronic disease in the neonates or pediatrics and adults sometimes needs supplements of oral electrolyte. Most of neonatal or pediatrics supplements of electrolyte have not existed in the local market (Table 1).[4] The formulations with different concentrations need to prepare as extemporaneously in the pharmacy with new Saudi vision 2030 and updated Pharmacy strategic plan. The goal of any health care intervention is to implement health economic and pharmacoeconomic services,[2] that is including a cost analysis of medication formulations, for instance, pediatrics electrolyte preparation, cost analysis of pediatrics pharmacy services and cost avoidance of pharmacist impact. Several investigations had been done about cost analysis in Saudi Arabia. That's included the cost analysis of drug information services, cost analysis of the TPN and cost analysis of clinical pharmacy activities.[5-8] The authors based on their best knowledge; they are not aware of any local or international publications about cost analysis of oral electrolyte pediatrics formulations in Saudi Arabia or Gulf and the Middle East countries. The aim of the current study is to explore the cost analysis of oral electrolyte pediatrics formulation in the Kingdom of Saudi Arabia.

METHODS

It is a retrospective cost analysis of drug information services from past one year at 300-beds pediatrics and maternity hospital in Riyadh city, Saudi Arabia. It had inpatient admission, ambulatory care clinics and emergency departments. The hospital has a different specialty for women adults and pediatrics. It has several specialties including adult's endocrinology, adult's nephrology,

pediatrics, adult's cardiology, adult's internal medicine, adult's surgery, adult's critical care, NICU, PICU, obstetrics and gynecology. The hospital treats the common neonatal, pediatrics and women health disease. The hospital has serve the patient including inpatient pharmacy with units' dose drug distribution system, outpatient pharmacy and extensive extemporaneous pediatrics section and drug information center. The pharmacy computerized physician order entry with an electronic prescription in addition to the pharmacy had medications safety program. The pharmacy trained clinical and pharmacy student training programs. The extemporaneous section had very comprehensive evidence-based pediatrics formulations for neonates and pediatrics in the central region of Ministry of Health hospitals. The section received the specific formulation from physician and then the expert pharmacist applied the international standard of clinical compounding through providing to healthcare staff over eight hours per days for five days per a week. The pediatrics formulation consisted of antibiotics, anti-tuberculosis (TB) medications, anticonvulsant medications, Gastrointestinal (GI) drugs, anti-hypertension medications, electrolyte supplements, renal preparations, diuretics formulation, steroid perorations and other supportive substances formulation. The analysis of the cost was included the variable expenses like personal cost, material and supply cost. Fixed costs include direct cost, non-salary cost and overhead cost.[6,7] In addition to the cost of compounding substances, number of preparations and time of preparations. The price was derived from the Ministry of Health information database. All cost was used US dollar currency. The study analyzed pediatrics electrolytes pediatrics formulations through the Microsoft Excel sheet version 10th.

RESULTS

The estimated average total standard cost of pediatric formulations per hour was (53.82 USD) and consisted of 58.58% (31.53 USD) for personal cost, 25.14% (13.53 USD) for overhead cost, 3.34% (1.8 USD) for material and supply cost, 12.93% (6.96 USD) for non-salary cost (Table 1 and 2). The average estimated cost of potassium chloride 10% per each preparation was (2.053 USD) with consisted of standard cost (0.48 USD) and the direct cost was (1.573 USD). The total annual cost of potassium chloride 10% was (172.452 USD) (Table 3). The average estimated cost of potassium chloride 7.5% per each preparation was (1.342 USD) with consisted of a standard value (0.158 USD) and the direct cost was (1.184 USD). The total annual cost of potassium chloride 7.5% was (228.14 USD) (Table 4). The average estimated cost of sodium bicarbonate 8.4% per each preparation was (0.7551 USD) with consisted of standard cost (0.37 USD) and the direct cost was (0.3851 USD). The total annual cost of sodium bicarbonate 8.4% was (54.36 USD) (Table 5). The average estimated cost of calcium carbonate 200 mg/mL per each preparation was (5.45 USD) with consisted of standard cost (0.84 USD) and the direct cost was (4.61USD). The total annual cost of calcium carbonate 200 mg/mL was (1,046.4 USD) (Table 6). The average estimated cost of sodium chloride 5.8% per each preparation was (1.117 USD) which consisted of a standard value (0.179 USD) and the direct cost was (0.938 USD). The total annual cost of sodium chloride 5.8% was (167.55 USD) (Table 7).

DISCUSSION

Several electrolyte products registered in the Kingdom of Saudi Arabia and overseas countries (Table 1). For most of the potassium chloride syrup with came with specific concentration and mixed multivitamins or other electrolytes. However, still, most of oral electrolytes were not manufactured and non-available in the Saudi or International Market.[9-12] Those electrolytes with different concentration badly demand for pediatrics. As results, the current extemporaneous preparation unit at the local hospital pharmacy prepared those products for patients referred to the hospital. Those need to determine the cost analysis to calculate the extemporaneous budget and clarify the income and expenses of the hospital pharmacy through the current study. The findings showed the standard necessary foundations for all pediatrics formulations as indirect cost while the direct cost different from one product to another. Most of the cost foundations came from personal cost and a lesser amount from overhead cost that is related to pediatric formulations need mostly the pharmacist prepares the medications while less amount of equipment needed. The majority of the product came from a direct cost more than indirect cost. There were two different concentration of potassium chlorine 10% and 7.5% with size 100 ml. Both of them was used in Potassium supplements for pediatrics. The cost of lower concentrations were cheaper than registered medications in UK only that is related to direct cost higher than indirect cost with a low number of products. The calcium carbonate syrup cost was higher then what is not registered in the Saudi or UK and USA.[9-12] The number of calcium carbonate products was low while

Table 1: The Cost of the electrolytes pediatric formulation in famous countries.

Medications name	Cost Current study		Cost in SA (USD) [10]		Cost in US (USD) [11]		Cost in UK (USD) [12,13]	
	Conc. mg/ml	Volume	Conc. mg/ml	Volume	Conc. mg/ml	Volume	Conc. mg/ml	Volume
Potassium Chloride 10%	ml=0.02053 $	100 ml =2.053$	Not available	Not available	Not available	Not available	Non available	Non available
Potassium Chloride 7.5%	ml=0.004473 $	300 ml = 1.342$ (100 ml= 0.4473)	Not available	Not available	Not available	Not available	ml=0.0212 $	75 mg per 1ml 500 ml= 10.62 $ (100 = 2.124 $)
Sodium Bicarbonate 8.4%	ml=0.00755 $	100 ml=0.7551$	Not available	Not available	Not available	Not available	ml=0.5012 $	8.4 mg per 1ml 100 = 50.12 $
Calcium Carbonate 200mg/ml	1 mg/ml = 0.000272 $	100 ml =5.45 $	Not available	Not available	Not available	Not available	Non available	Non available
Sodium Chloride 5.8%	ml=0.00372 $)	300 ml = 1.117 $ (100 ml= 0.372)	Not available	Not available	Not available	Not available	Non available	Non available

Table 2: Standard cost analysis of pediatrics 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 3: Cost of Potassium Chloride10% (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 84 per year, the cost per one 100 ml	0.48
Direct cost	
Potassium Chloride = 10 GM	0.491
Simple Syrup 40 ml	1.067
Water to 100 ml	0.016
Total	1.573
Grand Total 100 ml per bottle	2.053
Annual Grand Total cost	172.452

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Table 4: Cost of Potassium Chloride 7.5% (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 30 min per one bottle	26.91
Total of preparation 170 per year, the cost per one 300 ml	0.158
Direct cost	
Potassium Chloride = 22.5 GM	1.104
Water to 300 ml	0.08
Total	1.184
Grand Total 300 ml per bottle	1.342
Annual Grand Total cost	228.14

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Table 5: Cost of Sodium Bicarbonate8.4% (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 30 min per one bottle	26.91
Total of preparation 72 per year, the cost per one 100 ml	0.37
Direct cost	
Sodium Bicarbonate = 8.4 GM	0.3584
Water to 100 ml	0.0267
Total	0.3851
Grand Total 100 ml per bottle	0.7551
Annual Grand Total cost	54.36

Refrences

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Table 6: Cost of Calcium Carbonate 200mg/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 3 hr per one bottle	161.46
Total of preparation 192 when needed per year, the cost per one 150 ml	0.84
Direct cost	
Calcium Carbonate 600mg= 50 tablet	4.53
Methyl Cellulose to 30 ml	0.06
Water to 150 ml	0.02
Total	4.61
Grand Total 100 ml per bottle	5.45
Annual Grand Total cost	1,046.4

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Table 7: Cost of Sodium Chloride 5.8% (USD).

Personal	31.53
Over Head cost	13.53
Material and supply	1.8
Non Salary cost	6.96
Total	53.82
Preparation time 30 min per one bottle	26.91
Total of preparation 150 per year, the cost per one 300 ml	0.179
Direct cost	
Sodium Chloride= 17.4 GM	0.858
Water to 300 ml	0.080
Total	0.938
Grand Total 300 ml per bottle	1.117
Annual Grand Total cost	167.55

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the manufactures produced a higher number of products. In sodium bicarbonate pediatric formulations syrup was not available in the market with calcium carbonate. However, calcium carbonate only registered in UK with higher cost that prepared in the extemporaneous preparation unit.[11,12] It was difficult to compare with the local or international market.[9,10] In the sodium chloride syrup was not registered in the local market and it's challenging to compare with it.[9-12] Most of the product came as a solid dosage form. All electrolyte pediatrics formulation should continue to prepare them because of much cheaper and most of them was not available in the market.[9-12] The cost analysis of electrolyte pediatrics formulation was essential to calculate the income and expenses through privatization changing and to meet new Saudi vision 2030.[2,13] All pediatrics formulations with mainly emphasis on new formulations, the cost analysis should be conducted updated annually.

CONCLUSION

The total parental nutrition is essential services for neonates and pediatrics. Besides, enteral nutrition is the next steps of oral feeding. Some of oral pediatrics formulation may be required for neonatal disease and crucial electrolyte among them. Most of the oral electrolyte pediatrics formulation is not available in the market. The extemporaneous preparation of oral Electrolyte and cost related is essential for medication availability and subsequently, the patient satisfaction. The cost analysis of pediatrics oral electrolyte formulation is part of pharmacoeconomic services within hospital pharmacy strategic plan implementation. The annual or biannually of a cost analysis of oral electrolyte pediatrics formulation is highly recommended in the kingdom of Saudi Arabia.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

TPN: Total Parenteral Nutrition; **NICU:** Neonatal Intensive Care Units; **PICU:** Pediatrics Intensive Care Units; **SFDA:** Saudi Food and Drug Authority; **WHO:** World Health Organization; **KSA:** Kingdom of Saudi Arabia; **USD:** United State Dollars; **GI:** gastrointestinal; **GERD:** Gastroesophageal reflex diseases, **MOH:** Ministry of Health; TB: tuberculosis; **USA:** United States of America; **UK:** United Kingdom.

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